Rocky Flats Environmental Technology Site

MAN-127-PDSP

PRE-DEMOLITION SURVEY PLAN
FOR D&D FACILITIES

July 15, 2002

REVISION 1

APPROVED ________________________	**/Chris Gilbreath**	**7/15/02**
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ABBREVIATIONS/ACRONYMS

ACM	Asbestos-containing material
CBDPP	Chronic Beryllium Disease Prevention Program
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cpm	Counts Per Minute
COC	Chain of Custody
D&D	Decontamination and Decommissioning
$DCGL_W$	Derived Concentration Guideline Level – Wilcoxon Rank Sum test
$DCGL_{EMC}$	Derived Concentration Guideline Level – Elevated Measurement Comparison
DDCP	Decontamination and Decommissioning Characterization Protocol
DOE	U.S. Department of Energy
dpm	Disintegrations Per Minute
DQA	Data Quality Assessment
DQOs	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
FDPM	Facility Disposition Program Manual
IPC	In-Process Characterization
K-H	Kaiser-Hill Company, L.L.C.
LAB	Local Area Background
LRA	Lead Regulatory Agency
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimum Detectable Concentration
mg/l	Milligram/Liter
NORM	Naturally Occurring Radioactive Material
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PDS	Pre-Demolition Survey
PDSP	Pre-Demolition Survey Plan
PDSR	Pre-Demolition Survey Report
PCBs	Polychlorinated Biphenyls
PQL	Practical Quantitation Limit
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RE	Radiological Engineer
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office
RLC	Reconnaissance Level Characterization

RSC	Removable Surface Contamination
RSP	Radiological Safety Practice
SBE	Survey Breakdown Structure
SCM	Surface Contamination Monitors
SME	Subject Matter Expert
SOW	Statement of Work
SVOC	Semi-Volatile Organic Chemical
TCLP	Toxicity Characteristic Leaching Procedure
TSC	Total Surface Contamination
TSCA	Toxic Substances Control Act
VOC	Volatile Organic Chemical
WAC	Waste Acceptance Criteria

1.0 INTRODUCTION

The Pre-Demolition Survey (PDS) is an important activity in the facility disposition process, as described in the Rocky Flats Environmental Technology Site (RFETS) Facility Disposition Program Manual (FDPM) and the RFETS Decommissioning and Decontamination Characterization Protocol (DDCP; K-H, 1999a). This PDS Plan (PDSP) presents RFETS' approach to conducting PDSs and provides guidance to decommissioning project managers on implementation of PDSs.

1.1 Applicability and Use

This Plan applies to all Site employees and subcontractors performing facility characterization._ The requirements in this Plan **SHALL** be used for all Pre-Demolition Surveys conducted at RFETS. Any changes or revisions to this Plan will be approved by the Kaiser-Hill Company, L.L.C. (K-H), Manager for Environmental Compliance, 771 Project, and the Department of Energy (DOE), Rocky Flats Field Office (RFFO). Major revisions will be transmitted to the Colorado Department of Public Health and Environment (CDPHE) and the Environmental Protection Agency (EPA) Region VIII for approval. **Deviations for implementing this plan SHALL be approved by the K-H Manager for Environmental Compliance, 771 Project, the DOE, the CDPHE and EPA Region VIII.**

1.2 Purpose

The purpose of this plan is to provide direction on how to verify, through characterization of buildings and associated equipment, that decommissioning objectives have been met before demolition and/or removal (e.g., to ensure that surfaces meet un-restricted release criteria for radiological and non-radiological constituents, and to verify residual levels of radiological and non-radiological contamination). Decommissioning objectives, including extent of decontamination, are presented in decommissioning decision documents. This PDSP presents details on how to consistently conduct PDSs in a compliant, technically defensible, and cost-effective manner. Details include data quality objectives (DQOs) and requirements for radiological and chemical characterization, radiological field instrumentation, laboratory analysis, data analysis and data quality assessment. Effective and efficient implementation of PDSs supports the goals of the Rocky Flats Cleanup Agreement (RFCA; DOE/RFFO, CDPHE, EPA, 1996) and RFETS' closure plans.

1.3 Survey Scope

PDSs are performed before building demolition to define the final radiological and chemical contamination condition of a facility and to quantify the amount (determining the volume) of floors, walls, ceilings, and roofing, as radioactive and non-radioactive. Final conditions **SHALL** be compared with the decision document objectives for radiological and non-radiological contaminants. PDSs will enable project personnel to make final removal/disposal decisions, develop related worker health and safety controls, estimate waste volumes by waste types and properly characterize anticipated Type 1 facilities.

For Type 1 facilities, the PDS **SHALL** be conducted as part of Reconnaissance Level Characterization (RLC) in order to "Type" and release these facilities (refer to DDCP, Section 2.2 and Appendix D). For Type 2 and Type 3 facilities, the PDS **SHALL** be performed before building demolition and/or removal, and characterization instructions **SHALL** be documented in a PDS characterization package. Results **SHALL** be documented in the RLC Report for Type 1 facilities and in the PDS Report (PDSR) for Type 2 and 3 facilities.

Prior to PDSs, isolation controls **SHALL** be established to ensure that areas do not become radiologically or chemically contaminated and that PDS data remain valid. If controls are not in place, areas could be contaminated prior to, during and after PDSs by adjacent activities and by traffic going through the areas. Such contamination or the *potential for contamination* would invalidate PDS data. Controls **SHALL** remain in affect until the facility is demolished and/or removed. In addition, prior to demolition or removal, a verification survey **SHALL** be conducted to confirm that controls have been effective.

2.0 DQOS FOR PDS

The following sections outline the DQO process utilizing the seven steps as identified in the D&D Characterization Protocol. These DQOs should be used verbatim in the preparation of project-specific characterization packages. If modification is warranted, justification for each modification **SHALL** be documented in the characterization package and in the PDSR.

2.1 The Problem

The problem involves determining whether or not the survey unit and each anticipated Type 1 facility, is properly typed and is suitable for unrestricted release in accordance with this plan.

2.2 The Decision

The decision is verification that objectives specified in the decommissioning decision document have been met (e.g., certain materials meet unrestricted release criteria for radiological and non-radiological constituents), that anticipated Type 1 facilities have been properly characterized as Type 1 facilities, or that residual levels of radiological and non-radiological contamination are known.

2.3 Inputs to the Decision

Inputs to the decision include the magnitude and location of data from preceding characterizations, including RLC and In-Process Characterization (IPC), PDS results, decision document action levels, unrestricted release criteria, waste management regulations, and waste acceptance criteria (WAC) for on-site and off-site treatment, storage and disposal facilities. Details are provided throughout the PDSP.

2.4 Decision Boundaries

The decision boundaries are the spatial confines of the facility, including rooms and sets of rooms, in two and three dimensions. Interior and exterior surfaces are included, including those below grade. Boundaries may be further defined in RFCA decision documents.

2.5 Decision Rules

The following are decision rules to be used during PDS:

Radionuclides

If all radiological survey and scan measurements (and sample measurements, where sample activity is translated to surface activity as described in Kaiser-Hill letter to DOE, RFFO, Application of Surface Contamination Guidelines from Department of Energy Order 5400.5, WAH-064-98, March 10, 1998) are below the surface contamination guidelines provided in DOE Order 5400.5 (Radiation Protection of the Public and Environment; see Table 7-1), the related areas and/or volume are considered not radiologically contaminated.

If any radiological survey or scan measurement exceeds the surface contamination guidelines provided in DOE Order 5400.5, the related survey unit must be evaluated per the statistical tests described in section 7.0, Data Analysis and Quality Assessment, of this plan.

If any radiological sample measurement (or disposal unit volume) exceeds 100 nanocuries per gram of transuranic material, the related volume of material is considered transuranic (TRU) waste.

Hazardous Waste

If decommissioning waste is mixed with or contains a listed hazardous waste, or if the waste exhibits a characteristic of a hazardous waste, then the waste is considered RCRA-regulated hazardous waste in accordance with 6 CCR 1007-3, Parts 261 and 268.

Hazardous Substances

If material contains a listed hazardous substance above a decision document action level (e.g., RFCA) and/or the CERCLA reportable quantity (40 CFR 302.4), the material is subject to CERCLA regulation (i.e., remediation and/or notification requirements).

Beryllium

If surface concentrations of beryllium are equal to or greater than 0.2 µg/100 cm^2, the material is considered beryllium contaminated per 10 CFR 850.

PCBs

If material contains PCBs, in a non-liquid state, from the manufacturing process at concentrations ≥50 ppm, the material is considered PCB Bulk Product Waste and subject to the requirements of 40 CFR 761.

If PCB contamination from a past spill/release is suspected, or if a PCB spill is discovered that has not been cleaned up, the associated material is considered PCB Remediation Waste and subject to the requirements of 40 CFR 761. PCB remediation waste includes: materials disposed of prior to April 18, 1978, that are currently at concentrations ≥50 ppm PCBs, regardless of the concentration of the original spill; materials which are currently at any volume or concentration where the original source was ≥500 ppm PCBs beginning on April 18, 1978, or ≥50 ppm PCBs beginning on July 2, 1979; and materials which are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under 40 CFR 761.

If a waste or item contains PCBs in regulated concentrations, the waste or item is classified as PCB-regulated material and subject to the requirements of 40 CFR 761.

Asbestos

If any one sample of a sample set representing a homogeneous medium results in a positive detection (i.e., >1% by volume), then material is considered ACM (40 CFR 763 and 5 CCR 1001-10).

2.6 Tolerable Limits on Decision Error

Acceptable false negative (α) errors for calculating the number of samples generally range from 1% to 10%. The default to be applied at RFETS is 5%. Other limits may be used, if agreed to, by the D&D Program Office, the Project Manager, DOE, and the Lead Regulatory Agency (LRA).

2.7 Optimization of Plan Design

Statistically based radiological surveying and sampling will be conducted per the guidance in Section 5.5 of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and the PDSP. The location of radiological survey/sampling points will be delineated per the guidance provided in Section 5.5 of MARSSIM and the PDSP. Radiological field measurement methods and instrumentation will be delineated per the guidance in Section 6 of MARSSIM and the PDSP. Radiological sampling and preparation for laboratory measurements will be delineated per the guidance in Section 7 of MARSSIM and the PDSP.

Refer to Section 4.0 for direction of characterization of non-radiological, chemical constituents.

3.0 RADIOLOGICAL CHARACTERIZATION

The Pre-Demolition Survey (PDS) is designed to demonstrate that DOE-added radioactive materials have been removed from RFETS facilities to the extent that residual levels of contamination are below the derived concentration guideline levels (DCGLs) or to document that residual levels above the DCGLs remain. This section of the PDSP describes how facilities should be divided into survey areas and survey units, and defines the methods for collecting radiological surveys and samples.

The survey will follow the guidance provided in MARSSIM. The survey design and procedures used to develop the design are based on the survey unit classification process. These classifications are as follows:

Non-Impacted:	Areas that have no reasonable potential for residual contamination.
Impacted Class 1:	Areas that have, or had prior to remediation, a potential for radioactive contamination, or known contamination above the $DCGL_W$.
Impacted Class 2:	Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$.
Impacted Class 3:	Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$.

Specific sections of MARSSIM may not be utilized for guidance for the following reasons:

- Automated Surface Contamination Monitors (SCMs) may be utilized in addition to portable instrumentation for the detection of total surface contamination, provided the instrument's minimum detectable concentrations (MDCs) meet the requirements outlined in Section 5.1 of this document. MARSSIM statistical calculations will not be performed on data collected with SCMs and its associated survey information management system, provided that there is 100% survey coverage. The use of these SCMs will fulfill the requirement for scan surveys as well.

- Current RFETS release criteria are not dose based, but instead are derived from DOE Order 5400.5. Information required to develop "area factors" has not been developed for RFETS. Therefore, average and maximum total contamination values derived from DOE Order 5400.5 will be used as the $DCGL_W$ and the $DCGL_{EMC}$, respectively.

In situ measurements may be utilized to fulfill the requirement for total surface contamination (TSC) measurements; media samples, and scan surveys, given that the requirements for detection sensitivity (per Section 5.0 of this document), and the minimum requirements delineated in Appendix A for survey frequency, are met. This is considered acceptable given that in situ gamma spectroscopy can detect and quantify activity on and within the surface media (in lieu of collecting samples for laboratory analysis).

NOTE: Any new technology that is utilized to demonstrate compliance with the requirements of this plan **SHALL** be discussed with the LRA prior to implementation.

3.1 General Survey Protocols

A stand-alone Survey Breakdown Structure (SBS) document should be developed by the assigned Radiological Engineers (REs) for each facility or facility cluster that will undergo PDS. The SBS will specify how facilities are sub-divided into survey areas and survey units and to account for all areas of a facility or cluster of facilities. The minimum information to be included includes: Survey Area, Survey Unit, Survey Unit description, classification, and justification for the classification.

3.1.1 Survey Design

PDS survey measurements **SHALL** be conducted in accordance with approved procedures and specific survey instructions provided in the survey packages. A sufficient number of measurements **SHALL** be taken to conclusively demonstrate that the PDS DQOs have been met. The measurements **SHALL** be obtained by conducting surveys using approved methods and techniques, such as surface scans, direct and removable surface activity measurements, and media samples.

Facilities **SHALL** be broken down into survey areas and survey units during the design of the PDS survey. A survey area is a general term referring to any portion of a facility. For example a survey area could be a group of facilities, a single facility, or one or more rooms within a facility. Survey units are generally a subset of a survey area and include areas with similar characteristics and contamination potential. Survey units are typically limited in size to ensure each area is assigned an adequate number of data points. The suggested maximum floor surface areas for survey units are:

Up to 100 m^2 floor area for Impacted Class 1 Areas
100 - 1000 m^2 floor area for Impacted Class 2 Areas
Up to 1000m^2 floor area for Impacted Class 3 Areas

These size restrictions are guidelines. However, significant deviations from these guidelines **SHALL** be discussed with the LRA. If additional measurements are collected, larger floor surface areas may be used. For example, if an area is classified as Impacted Class 1 and has 200 m^2 of floor surface area, then the number of measurements calculated would be multiplied by 2 to account for the increased surface area. In addition, no survey unit will be less than 10 m^2 in size in order to achieve an acceptable sample population. REs **SHALL** be responsible for dividing their respective facility into appropriate survey areas and survey units in accordance with PRO-475-RSP-16.01, Radiological Survey/Sampling Package Design, Preparation, Control, Implementation and Closure.

3.1.2 Survey Packages

Survey instructions and field data **SHALL** be documented in individual survey packages for each survey unit. Survey packages are prepared prior to the performance of PDS surveys. Survey packages contain the instructions, survey maps, and other necessary information to direct the performance of surveys. The survey instructions **SHALL** specify the minimum number, type and location of required survey measurements, and the amount of surface area contained within each survey unit. Survey instructions **SHALL** be specified on established forms and placed in the survey package.

The preparation of a survey package is a dynamic and interactive process. As a result, flexibility is required to permit survey personnel and supervision to resolve the various situations that may arise. To ensure data collection is optimized, all survey units should be walked down as a part of the survey package development. Survey packages **SHALL** be used to control, implement, and document PDS surveys in each area of a facility. REs **SHALL** be responsible for developing survey packages and survey instructions for their respective facility in accordance with PRO-475-RSP-16.01, Radiological Survey/Sampling Package Design, Preparation, Control, Implementation and Closure. Copies of the field survey data collected during the performance of the PDS survey **SHALL** be included in the respective survey package.

3.1.2.1 Measurement Frequencies

The quantity of surveys and samples SHALL be based on statistical calculations to satisfy impacted Class 1, Class 2, and Class 3 survey unit requirements. The number of data points is determined based on the selection of a statistical test (typically, the Sign Test will be utilized). Appendix A provides guidance on calculating the required number of measurements (based on the utilization of the One-Sample Statistical Test, or Sign Test). Biased measurements should also be collected at suspect areas (based on the potential for contamination). REs SHALL be responsible for determining the number of survey locations and samples for each survey unit for their respective facility in accordance with PRO-475-RSP-16.01, Radiological Survey/Sampling Package Design, Preparation, Control, Implementation and Closure. Note, during this phase of characterization, scanning frequencies will be determined through the consultative process.

3.1.2.2 Designating Measurement Locations

Survey maps **SHALL** be used to define the boundaries of survey units and to document measurement locations. Measurement locations should be clearly identified to provide a method of referencing survey results to survey/sample locations. PDS measurement locations should be identified on the facility surfaces using self-adhesive labels, or equivalent. The labels, or equivalent, should be annotated with the corresponding survey map reference location number. Since RLC measurement locations may also be identified on the facility surfaces using self-adhesive labels, or equivalent, the PDS labels should be unique relative to the RLC labels (e.g., different colored labels). Survey maps **SHALL** be developed by the RE for each survey unit in accordance with PRO-475-RSP-16.01, Radiological Survey/Sampling Package Design, Preparation, Control, Implementation and Closure.

3.1.2.3 Surface Scans

Scanning surveys **SHALL** be performed to search for areas above the release limits (i.e., detect localized areas above the release limit). The scanning methods utilized (instrument and survey technique) **SHALL** be designed to detect at, or below, the release limits. If an area of elevated activity is identified during scanning, a follow-up total surface activity measurement **SHALL** be performed to verify the result is less than the DCGLw. If confirmed, a follow-up investigation **SHALL** be performed per RSP 16.02 *Radiological Surveys of Surfaces and Structures*. These "biased" measurements should not be included in the statistical test, but should be compared directly to the release limits. (for individual 100 cm^2 measurements) and the $DCGL_W$ (for the square meter average). Refer to Appendix A for required scan frequencies.

Note that the surface scan coverage is presented as a range for both Class 2 and Class 3 survey units. Surface scans for Class 2 survey units should target those areas with the highest potential for contamination (typically floors and lower walls). Biased scans, between the range of 1-10% of the total surface area for Class 3 survey units, should also target areas with the highest potential for contamination including high traffic areas such as building entrances, exits, and hallways; HVAC intakes and exhaust ducts; storage areas; areas of frequent personnel contact such as doors and door frames, horizontal surfaces, etc. Radiological Engineering **SHALL** determine the scan frequency for Class 2 and 3 survey units based on process history, past radiological survey results (as available), and potential for contamination. The scan frequency should be increased if extensive contamination is identified. In addition, the scan frequency on the upper walls, and ceiling should be increased if extensive contamination is detected on the lower walls (i.e., contamination may have migrated further up the wall than initially anticipated).

3.1.2.4 Surface Activity Measurements

Total and removable surface activity measurements **SHALL** be collected at random (Class 3) or systematic (Class 1 and 2) measurement locations (refer to Appendix A). Additional "biased" measurements may be collected at areas of elevated activity identified during the scan (refer to section 3.1.2.3). Specific guidance regarding the location and number of measurements **SHALL** be provided in survey package instructions. Surface activity measurements **SHALL** consist of total and removable measurements at each location. Instruments utilized for the detection of total and

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removable surface activity **SHALL** have an *a priori* minimum detectable concentration (MDC) no greater than the 50% of the $DCGL_W$ (averaged over one square meter) (refer to section 5.1). Both positive and negative measurement results **SHALL** be recorded. Measurements that are flagged as exceeding the associated action level or release criteria **SHALL** be verified by the cognizant radiological engineer to represent **actual** DOE-added contamination (versus naturally-occurring material or statistical anomalies) prior to the decision-making process. Methods to distinguish between DOE-added and naturally-occurring material include, but are not limited to, the following:

Isotopic determination (via *in situ* spectroscopy or physical sampling and analysis) TBD-00156, Using Graphical Data Distribution Analysis to Distinguish between Background and DOE-added Materials in Environmental Data Sets (NOTE: This method will not eliminate the need for sampling, but is a tool that will reduce the number of structures and/or survey units that will require sampling).

Scan survey results may be utilized to satisfy the requirement for total surface activity measurements if a 100% scan is performed in the survey unit (or all randomly-selected locations are scanned), and the MDC of the scan instrument achieves the *a priori* MDC of 50% of the $DCGL_W$ averaged over a one square meter area (refer to Section 5.1).

3.1.2.5 Surface Media Sampling

Surface media sampling may not be necessary during the PDS because the media and surfaces will have already been characterized and remediated, if necessary, prior to the PDS phase. Areas that have not been remediated or previously sampled that have the potential for contamination in excess of the $DCGL_W$ **SHALL** be sampled during the PDS phase. If required, surface media samples (e.g., paint, flooring material, roofing material, sediment, etc.) **SHALL** be collected at the total/removable surface activity measurement locations (refer to Appendix A). Various methods may be utilized to collect samples, depending on the matrix type. The depth of the potential contamination should also be considered when selecting a sampling method. Sampling methods include, but are not limited to, scraping of the surface layer, sawing (through the tar and ballast layer for roofs), and coupon sampling (for metal roofs, metal siding, etc.).

If roof samples are required, the following should be considered:

The size (total mass) of the sample should be minimized in order to avoid the skewing of results towards high values (due to the fact that the pCi/g value will be converted to a dpm/100 cm^2 value). The ideal sample size is 100 square centimeters.

Sample results are more easily compared for like samples (paint, tar, gravel, concrete, etc.). Therefore, it may be more practical for data analysis purposes to consider the roof a separate survey unit from the building exterior walls (typically painted metal or concrete, or bare concrete).

3.1.2.5.1 Background Subtraction

There are two types of background subtraction values that can be subtracted from gross total surface activity measurement results. One of the background types is the "local area background (LAB), and the other type is the "material background."

Local area background represents the instrument response to environmental levels of radiation. A local area background is typically subtracted for conventional field survey instruments, and is determined by collecting a single background measurement at every PDS measurement location. The average of the data set is then subtracted from each gross measurement to calculate a net measurement. For alpha radiation, a local area background can be established by turning the probe face away from the measurement location. For beta radiation, a shield would typically be utilized.

Material background is the background seen when an unshielded detector probe is placed directly on a non-impacted surface containing naturally occurring radioactive material (NORM). The counts seen are due to the combination of NORM on the surface and the LAB. Since alpha emitting NORM is insignificant relative to the alpha $DCGL_W$ criteria, no material background subtraction will typically be performed on alpha PDS survey results (i.e., a conservative value of zero will be used). An alpha material background subtract may be utilized if a high natural background component is present (e.g. ceramic, porcelain). Refer to PRO-480-RSP-16.06, Radiological Background Determination, for guidance in estimating background.

When beta-gamma emitting PDS surveys are obtained, a material background subtraction may be used. The survey package initiator (RE) **SHALL** provide adequate documentation of the material background value to be utilized during PDS. Guidance on determining background is provided in PRO-480-RSP-16.06. If beta-gamma emitting material background subtraction values are not available, or a radiological engineering evaluation determines that material background values are not necessary, then a conservative material background value of zero **SHALL** be used.

3.1.2.6 Investigation Action Levels

Investigation Action Levels refer to the level at which some corrective action must be taken in order to demonstrate compliance with the requirements of this plan. Tables 3-1 and 3-2 describe the conditions under which investigations **SHALL** be performed on PDS results. Prior to performing the investigations described in the tables, the following should be performed per RSP 16.02, *Radiological Surveys of Surfaces and Structures:*

state of the area (i.e. the original result was not a "false-positive").
2) Verify that the elevated result is due to DOE-Added material versus naturally-occurring material (e.g. radon or radon progeny).
3) Investigate the origin of the contamination (i.e. historical operation/process or the result of D&D activities) in order to determine the appropriate follow-up actions.
4) Assure that a pattern of contamination does not exist by reviewing other survey/sample results (especially applicable to media samples).

NOTE: Refer to Section 3.1.2.7 for additional guidance for Class 2 and Class 3 survey units.

NOTE: The default investigation action level for areas of elevated activity identified during scanning is the DCGLw. If outside vendor instrumentation is utilized (e.g., SRA position-sensitive proportional detector), the appropriate action (flag) levels will be developed specifically for this instrumentation and will be discussed with the LRA prior to implementation.

Table 3-1 Impacted Class 1 and 2 Survey Unit Investigations

Condition	Follow-up Actions *
1) Any total surface contamination or media sample result taken exceeds the $DCGL_{EMC}$.	1) Remediate and resurvey.
2) Any total surface activity measurement performed as a result of the identification of an area of elevated activity during scanning exceeds the DCGLw.	2) Perform a total surface activity measurement at the flagged area to assure the actual value is less than the $DCGL_W$. If the follow-up total surface activity measurement exceeds the $DCGL_W$, then additional measurements must be collected within the contiguous square meter to verify that the average contamination level in that square meter is less than the $DCGL_W$. If not, the area must be remediated.
3) The average value for total surface activity or media samples results for the survey unit exceeds the $DCGL_W$ (i.e., sign test fails).	3) Assure the initial survey design is appropriate. Adjust survey design as necessary. Remediate and/or resurvey.
4) Any single removable activity result exceeds the applicable $DCGL_W$.	4) Remediate and resurvey.

* **NOTE:** Reclassification and resurvey may not be necessary if the contamination can be attributed to a known D&D activity. For this case, the area of potential contamination can be readily identified and remediated.

Table 3-2 Impacted Class 3 Survey Unit Investigations

Condition	Follow-up Actions*
5) Any total surface activity or media sample result exceeds the $DCGL_W$.	9) Reclassify and resurvey.
6) Any total surface activity measurement performed as a result of the identification of an area of elevated activity during scanning exceeds the $DCGL_W$.	10) Perform a total surface activity measurement at the flagged area to assure the actual value is less than the $DCGL_W$. If the follow-up total surface activity measurement exceeds the $DCGL_W$, then additional measurements must be collected within the contiguous square meter to verify that the average contamination level in that square meter is less than the $DCGL_W$. If not, the area must be remediated, reclassified and resurveyed.
7) The average value for total surface activity or media sample results for the survey unit exceeds 75% of the $DCGL_W$ (i.e., sign test fails).	11) Reclassify and resurvey (remediation may also be required).
8) Any single removable activity result exceeds 75% of the $DCGL_W$.	12) Remediate, reclassify and resurvey.

NOTE: Reclassification and resurvey may not be necessary if the contamination can be attributed to a known D&D activity. For this case, the area of potential contamination can be readily identified and remediated.

The above methodology **SHALL** be utilized to meet the intent of DOE Order 5400.5, in that the average contamination values over 1 m^2 for total surface activity measurements cannot exceed the $DCGL_W$ limits listed in Table 7-1, provided that no single total surface activity measurement exceeds the $DCGL_{EMC}$ limits listed in Table 7-1. The above methodology **SHALL** also be utilized for media samples.

3.1.2.7 Survey Unit Reclassification

Impacted Class 3 survey units may require reclassification based on updated survey information. In the event contamination is identified and confirmed (based on the conditions described in Table 3-2), then the following guidelines apply:

1) A new survey unit with a more restrictive classification (Class 1 or Class 2) may be developed to encompass the area of investigation as directed by radiological engineering, or

2) The entire survey unit may be reclassified as Class 1 or Class 2.

Impacted Class 2 areas may require reclassification based on updated survey information and sound engineering judgement. Conditions under which reclassification may apply include the following:

1) Evidence of uniform contamination at or above the $DCGL_W$ exists in the survey unit.
2) The cause and/or affected area of contamination cannot be readily identified and bounded (in order to create a separate and unique Class 1 survey unit).

Based on characterization survey results and sound engineering judgment, areas may be downgraded if the new classification criteria are met. For example, an Impacted Class 1 area with extensive survey results that indicate that contamination levels are not expected to exceed the applicable $DCGL_W$ may be reclassified as Impacted Class 2.

3.2 PDS Isolation Controls

Two levels of isolation controls **SHALL** be established during and after the PDS for each area. The level of isolation control **SHALL** be based on the classification of the survey unit and the potential for cross contamination or re-contamination.

3.2.1 Discussion

Implementation of isolation control measures is required to ensure areas prepared for PDS remain below the unrestricted release criteria for radiological contamination during and after PDS. Isolation controls should also be in place during a characterization survey IF the data will be utilized to demonstrate compliance with PDS requirements.

For survey units or groups of survey units, the use of postings and physical barriers **SHALL** provide visible indicators of areas and equipment that have been surveyed and for which isolation controls have been established. These postings **SHALL** consist of signs, ropes, or other similar barriers.

Radioactive material with the exception of instrumentation calibration check sources, **SHALL** be restricted from these isolation control areas.

The applicable areas with established isolation controls **SHALL** have investigation surveys performed subsequent to any potentially contaminating events as determined by radiological engineering.

3.2.2 Levels of Control

3.2.2.1 Level 1

Areas where the potential for the spread of contamination or the movement of radioactive material is significant may be classified as Level 1 and would require restrictive controls. Typical Level 1 areas include areas adjacent to contamination areas (CAs), radiological buffer areas (RBAs), or areas where radioactive material is stored (except instrumentation calibration check sources).

Mandatory isolation controls include the following, as applicable:

1) Training of personnel on isolation controls
2) Posting appropriate labels at access points
3) Installing temporary physical barriers with step-off pads and survey instrumentation for personnel monitoring prior to entering the area

Additional isolation controls include the following, as determined as applicable by radiological engineering:

1) Installing tamper-indicating devices
2) Additional isolation controls as appropriate
3) Locking entrances

3.2.2.2 Level 2

Areas where the potential for the spread of contamination or the movement of radioactive material (except instrumentation calibration check sources) is not significant may be classified as Level 2.

Mandatory isolation controls include the following as applicable:

1) Training of personnel on isolation controls
2) Posting appropriate labels at access points

Additional isolation controls could be used, as determined as appropriate by radiological engineering.

3.2.3 Implementation

The assigned radiological engineer for each individual survey package **SHALL** establish isolation controls. Prior to the start of the PDS, the Radiation Safety Authority or designee **SHALL** ensure that prescribed isolation control measures are in place for the specific survey unit(s) as delineated in the individual survey package.

4.0 CHEMICAL CHARACTERIZATION

For Type 2 and Type 3 facilities, data to support Pre-Demolition Survey with regard to chemical contaminants will be collected to a large extent during Reconnaissance Level Characterization (RLC) or In-Process Characterization (IPC) when material and equipment are being removed. If sampling to determine the presence or absence of contamination has not been completed during IPC, additional sampling and analysis **SHALL** be conducted as part of a Pre-Demolition Survey Plan. For Type 1 facilities, sampling during the characterization to meet the PDS objectives will be conducted during RLC. For all facility types, these data will be sufficient to:

Verify that chemical contaminants are absent or below levels necessary for unrestricted release or disposal as sanitary waste; or Document levels of contamination; and allow accurate segregation of all waste streams.

Characterization **SHALL** address all potential hazardous wastes and hazardous substances pursuant to the decision rules specified in Section 2.5, even though only the most common contaminants are addressed below. In addition, all chemical analysis **SHALL** be conducted in accordance with the K-H Analytical Services Division Statements of Work (refer to Section 6.0).

Prior to planning for sampling and analysis, reviews of anticipated disposal sites should be conducted so that the analytical data necessary to meet the receiving facility's disposal requirements (WAC and waste analysis plan) are generated in one sampling event. In this fashion, the number of sampling and analysis events would be minimized.

4.1 Lead and Other RCRA Metals

All materials, equipment, or media suspected of containing lead and/or other RCRA metals (e.g., construction materials such as shielding, and surfaces potentially containing residue from metal chemical processes, treatment, or spills) **SHALL** be managed as hazardous waste, unless either process knowledge or analytical data establish that the materials are not hazardous waste. Samples of paint chips, concrete, wall-board and other materials may be taken as necessary to support waste characterization or IH concerns.

Historical data sources such as the Waste and Environmental Management System, Waste Stream and Residue Identification and Characterization (WSRIC) reports, the Site RCRA Permit, the Historical Release Report, maintenance records, blueprints, as-built drawings, specifications, and emergency response documents **SHALL** be consulted to determine if processes involving RCRA metals have been conducted in the area being characterized. If so, evaluations **SHALL** be conducted to determine whether contamination occurred. Evaluations can be based on process knowledge and/or sampling and analysis of suspected media.

In general, porous materials in contact with RCRA-listed or -characteristic waste or with hazardous material **SHALL** be subjected to total and/or Toxicity Characteristic Leaching Procedure (TCLP) analysis. For example, processes involving metal-based oxidants for control of algal and fungal growth (e.g., hexavalent chromium compounds) may have been conducted in water holding tanks or treatment facilities. If no information is available about levels of potential residues, media samples potentially in contact with the metal contaminant **SHALL** be taken for TCLP analysis (e.g., concrete or sludge; refer to Section 4.1.1 for details). Scrap metal bound for recycling will generally not be sampled since they are not subject to RCRA limits. However, sampling may be conducted to obtain information for worker protection prior to D&D operations (e.g., torch cutting of pipes). If materials are located in a RCRA unit and will be included under RCRA closure activities, they will be characterized under a RCRA closure plan and subject to RCRA performance standards. In some circumstances, such as for IH requirements, identification of RCRA-listed constituents, or determination of underlying hazardous constituents under RCRA, a total metals analysis may be performed on media to provide characterization information.

4.1.1 Sample Types and Locations

A physical tour of each building **SHALL** be conducted to identify suspect (or affected) materials that may indicate through historical data or based on the inspector's experience, the presence of lead or other RCRA metals. A suspect list **SHALL** be generated, along with estimated quantities. Generic types of materials potentially containing lead and other RCRA metals include but are not limited to the following:

paints and coatings, characterized by color, texture, and luster
gloveboxes and associated shielding equipment
piping
solder joints for piping and electrical components
plates, bars, brackets, and shields
lead fills in walls
skirting
additives (e.g., in plaster)
areas in which chemical processes, treatment, or storage involving metals or metal compounds are known or suspected to have taken place (e.g., hexavalent chromium treatment).

Bulk lead is expected to be a common form of lead generated during D&D efforts. In general, TCLP analysis of lead in this form yields a result greater than the 5.0 mg/L regulatory level listed under 6 CCR 1007-3, Part 261, and the lead must be treated as RCRA waste and assigned hazardous waste number D008. Sampling and TCLP analysis of this form of waste stream is considered excessive for purposes of designating the waste as hazardous, based on reliable process knowledge that indicates the waste is hazardous. As a result no sampling of the bulk lead is necessary for determination of the related waste as hazardous.

For media other than paint or coatings where lead or metals contamination is suspected based on color, age, or other characteristics, core or grab samples **SHALL** be taken for TCLP analysis by a method described in the *Bulk Solids and Liquids Characterization Procedure* (PRO-488-BLCR) or the *Metals and PCB Characterization Procedure* (PRO-487-MPCR). It is expected that a minimum of three samples plus a duplicate QC sample will be taken. However, in some situations involving relatively small areas (sumps, stains beneath a value, etc), the media can be adequately characterized by taking just one sample and a duplicate. For large areas, the number of "QC" samples should not exceed 10% of the "real" sample number. The decision to take biased samples and/or random samples will be made by the field manager and the subject matter expert (SME) involved with the project. The locations of the random samples **SHALL** be determined by generation of a grid as described below in Section 4.3.1.

Alternatively, a representative sample of an individual waste stream (e.g., a solid or liquid found in a floor sump or manhole) **SHALL** be subjected to TCLP analysis, and the resultant values compared to the regulatory levels given by 6 CCR 1007-3, Part 261, and/or a total analysis for waste management decision-making.

Special considerations for lead paints and coatings

RFETS has determined, using process knowledge and site-specific analytical measurements, that painted surfaces in most areas have metal concentrations above the toxicity characteristic values stipulated in 6 CCR 1007-3, Part 261, however, taken as a whole, the demolition debris will not have concentrations above the regulatory limits. Therefore painted surfaces do not require sampling (Environmental Waste Compliance Guidance No. 27, *Lead Based Paint (LBP) and LBP Debris Disposal)*. However, painted surfaces in high contamination areas (HCAs) may exceed the toxicity characteristic values and SHALL be managed as hazardous waste unless verifying analytical data are obtained. For HCA sampling, each surface with a different paint type (as categorized by color, texture and lustre) SHALL have two samples taken by the method described in the *Metals and PCB Characterization Procedure* (PRO-487-MPCR), with the second sample considered a duplicate for evaluation of overall project precision.

Sampling of lead levels in paints and settled dust may be required for assessment of IH issues, such as work practices, engineering controls, and decisions on PPE. This is particularly important in areas where lead-coated surfaces are to be scraped, scabbled, torched, or otherwise disturbed in such a way as to cause lead particles or dust to potentially become airborne. In addition to lead-based paint, zinc-based rust inhibitors applied to steel I-beams also contain lead, and may be a source of potential airborne lead during decommissioning, removal, or demolition of structures. In all cases, the Project Manager, with IH support as needed, SHALL ensure that all requirements in the Occupation Safety and Health Administration (OSHA) Lead Standard (29 CFR 1926.62) for lead measurements and worker safety are met in these instances.

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Paints may also need to be sampled and analyzed to determine how to manage scabbled paint residues (e.g., as hazardous waste).

4.1.2 Sampling Methodologies

All samples **SHALL** be collected by the method appropriate to the type and location of the suspected metal contamination, as described in the Metals and PCB Characterization Procedure. When TCLP is used, EPA SW-846, Method 1311 **SHALL** be employed for sample preparation. EPA SW-846 specifies details and methods for the determination of lead and other metals, including cadmium, chromium, zinc and arsenic, in solids. These sampling procedures include:

Coring. Coring will be the preferred method for bulk sampling. Coring techniques are described in the Bulk Solids and Liquids Characterization Procedure (PRO-488-BLCR), and are based upon American Society for Testing and Materials (ASTM) Method E1729-95, "Standard Practice for Field Collection of Dry Paint Samples for Lead Determination by Atomic Spectrometry."

Paint chip analysis. The technique for removal of paint chips utilizing a chisel, putty knife, blade, etc., is described in the Metals and PCB Characterization Procedure (PRO-487-MPCR), and is based upon American Society for Testing and Materials (ASTM) Method E1729-95, "Standard Practice for Field Collection of Dry Paint Samples for Lead Determination by Atomic Spectrometry".

Each sample **SHALL** be described in the sampling log with respect to location, sample source (i.e., floor, table, glovebox, etc.), and paint color, if applicable, in such a way that it is uniquely identified for follow-up sampling if needed.

Samples submitted for the determination of Total Metals **SHALL** be prepared for analysis following one of the 3000 Series methods in EPA Publication *Test Methods for Evaluating Solid Waste, Chemical and Physical Methods* (SW-846). The preparation technique selected **SHALL** be appropriate for the instrumental technique that will be used to analyze the sample. The only acceptable instrumental techniques are the 6000 and 7000 Series methods listed in SW-846. When samples are submitted for the determination of leached concentrations via the Toxicity Characteristic Leaching Procedure (TCLP), the most current version of EPA SW-846, Method 1311 **SHALL** be employed for sample preparation. TCLP extracts **SHALL** be analyzed per SW-846 Method 6010B, 6020, or any of the 7000 series.

4.2 VOCs and SVOCs

Volatile organic compound (VOC) and semi-volatile organic compound (SVOC) contamination, if present, is expected to be confined to localized areas surrounding locations where such chemicals were used, stored or spilled, particularly in enclosed spaces, or absorbed into porous media. Even though the contaminants are by definition volatile, they may remain present in porous media for a significant length of time, particularly if the surface has been painted or if other activities have taken place which might impede volatilization and dispersal.

Historical records **SHALL** be consulted to discover whether use or storage of VOCs/SVOCs occurred in the building, which specific VOCs/SVOCs were used, for what purpose were they used, where within the building these activities took place, and whether spills have been recorded or suspected. A physical tour of the building **SHALL** be conducted to identify areas suspected of VOC/SVOC contamination. A list **SHALL** be generated, along with an estimate of the size of the area likely to be involved.

Several VOCs are classified as listed or characteristic wastes under RCRA. If characteristic contaminants are suspected, intrusive samples **SHALL** be conducted as described for TCLP analysis. If wastes are suspected to contain a listed VOC or SVOC, or if land disposal restrictions (LDRs) must be addressed, intrusive samples **SHALL** be collected for total analysis.

4.2.1 Sample Types and Locations

During the physical tour of the building, particular attention **SHALL** be paid to storage cabinets, enclosed spaces, tanks, equipment or pipes likely to contain solvents and areas of staining on the floor, particularly on porous surfaces into which VOCs/SVOCs may have penetrated. If leaking containers are present, the identity of their contents **SHALL** be noted, and an estimate of the volume of the spill **SHALL** be made if possible.

Suspect areas and materials may be screened with a photoionization detector and flame ionization detector (PID/FID) for detectable organic vapor concentrations, operated in accordance with Procedure F0.15, *Photoionization Detectors and Flame Ionization Detectors*. It is important to note that PID/FID do not detect all VOCs/SVOCs. In cases that require opening an enclosed space, vat, pipe, or piece of equipment, IH **SHALL** ensure that proper safety precautions are met to avoid worker exposure, asphyxiation danger, or fire/explosion hazard.

If VOC/SVOC contamination is deemed likely, an investigation of historical records and process knowledge **SHALL** be undertaken to determine the likelihood that the contaminant is a RCRA listed or characteristic material. If the identity of the contaminant cannot be definitely established as a RCRA listed or characteristic material, or if RCRA listed or characteristic materials are found to have been used or stored in the area, sampling **SHALL** be undertaken as in Section 4.2.2. For spills on porous materials, core or grab samples **SHALL** be taken for either total or TCLP analysis (as appropriate depending upon whether the suspect spill is a listed or characteristic waste, respectively) by a method described in the *Bulk Solids and Liquids Characterization Procedure* (PRO-488-BLCR). It is expected that a minimum of three samples and a duplicate sample will be taken. However, in some situations involving relatively small areas (sumps, stains beneath a value, etc), the media can be adequately characterized by taking just one sample and a duplicate. For large areas, the number of "QC" samples should not exceed 10% of the "real" sample number. The decision to take biased and/or random samples will be made by the field manager and the SME involved in the project. The locations of the random samples **SHALL** be determined by generation of a grid as described below in Section 4.3.1.

Alternatively, a representative sample **SHALL** be subjected to TCLP, and the resultant values compared to the regulatory levels given by 6 CCR 1007-3, Part 261, and/or a total analysis for waste management decision-making.

4.2.2 Sampling and Analysis Methodologies

For spills on porous materials, a minimum of three intrusive samples and a duplicate **SHALL** be taken by a method appropriate to the medium upon which the spill has occurred. For liquids, a sample representative of the liquid **SHALL** be taken. For spills upon non-porous materials, an appropriate sampling procedure **SHALL** be developed and implemented, based on the specific situation, under IH supervision. Due to potential risks of flammability and explosion, IH **SHALL** determine proper safety precautions. Sampling **SHALL** be carried out by a method described in the Bulk Solids and Liquids Characterization Procedure, PRO-488-BLCR.

Samples submitted for the determination of Total Volatile Organic Compounds or Total Semi-volatile Organic Compounds (SVOCs) **SHALL** be prepared for analysis following the appropriate 5000 Series method in EPA Publication SW-846. The analysis for VOCs **SHALL** be performed per EPA SW-846 Method 8260B, and the analysis for SVOCs **SHALL** be performed per SW-846 Method 8270B. When TCLP is used, the EPA SW-1311 preparation method **SHALL** be employed. Samples **SHALL** be analyzed according to the EPA SW-846 Method 8260B for VOCs and Method 8270C for SVOCs.

4.3 Beryllium

All facilities **SHALL** be evaluated for potential beryllium (Be) contamination. The evaluation will be based on historical and process knowledge, and sampling and analysis as necessary.

Historical records **SHALL** be consulted to determine whether Be activities or storage are known to have occurred at the building being characterized and, if so, in which rooms or areas activities or storage took place. This determination **SHALL** include consulting the Location of Known Beryllium Areas (LKBA) and the Chronic Beryllium Disease Prevention Program (CBDPP). The LKBA does not specifically address locations of beryllium storage. For example, when beryllium materials were consolidated for removal from Bldg. 779, beryllium materials were found in 16 rooms not previously identified. It is also important to consider proximity to buildings that may be Be contaminated, nearby individual hazardous substance sites (IHSSs) that may contain Be, and possible cross-contamination from contaminated workers. The CBDPP surveys have included the following:

Random, statistically-based surface contamination surveys of readily accessible surfaces;
Biased surface contamination surveys of readily accessible surfaces in rooms where beryllium activities are known to have occurred; and
Breathing zone air samples in areas known or suspected to have Be surface contamination levels in excess of 0.2 μg/100 cm^2.

The CBDPP surveys historically did NOT address less accessible surfaces important for D&D considerations, such as horizontal surfaces of ductwork and hoods, light fixtures, rafters, ledges, and other surfaces not readily accessible to traffic and cleaning (e.g., between equipment). Because workers may be exposed to airborne Be during stripout of these surfaces and because data are needed for removal and/or disposal, further Be swipe samples **SHALL** be taken as necessary to adequately characterize all surfaces.

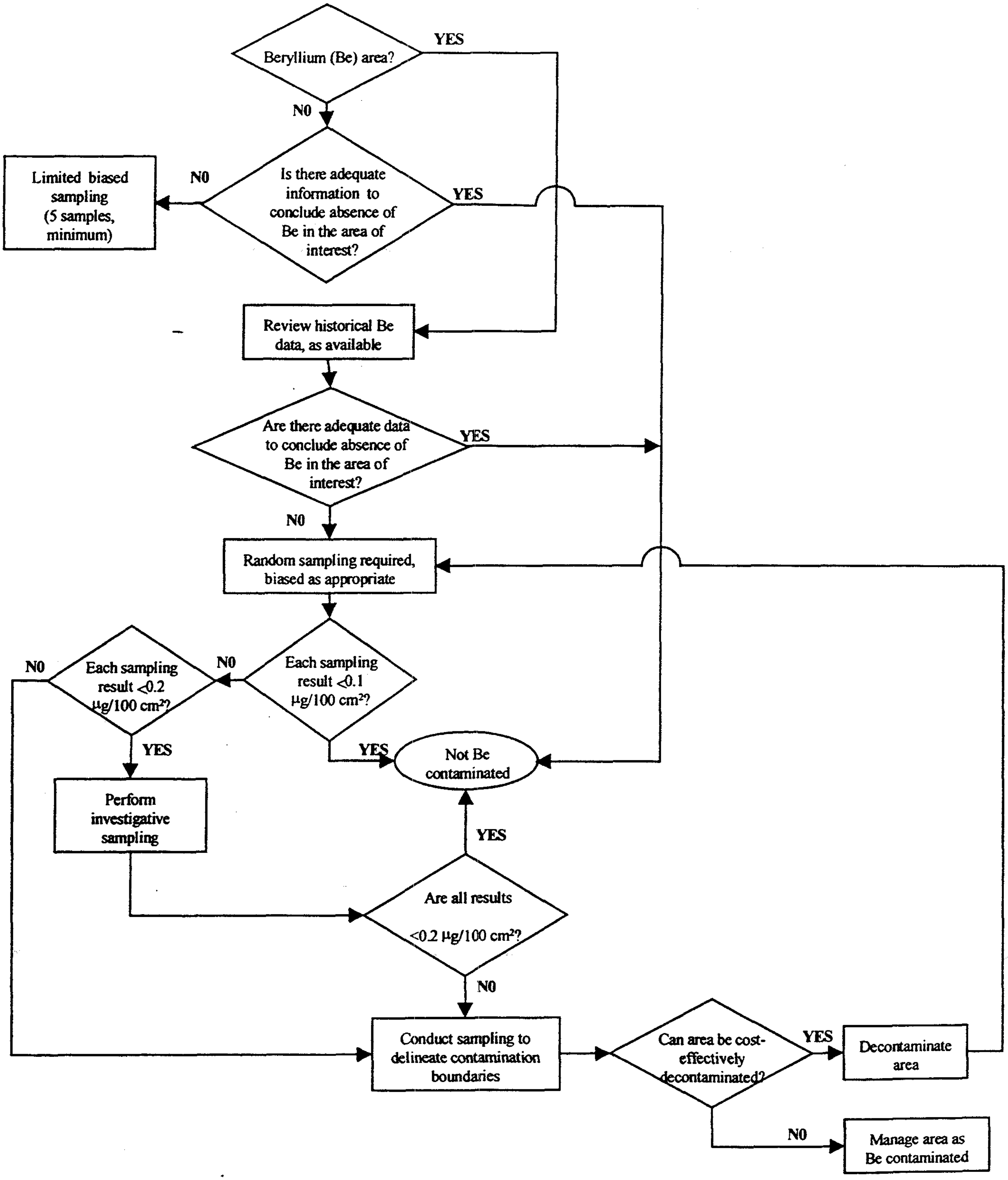
RFETS has determined, using process knowledge, that the majority of beryllium (Be) dust, particles, scrap, and other products of Be metal processing carried out at RFETS do not meet the criteria for a RCRA hazardous waste. However, some Be powder in the form of a product of a chemical process (P015 listed under RCRA) was used on-site. If it can be proven and documented through historical records and process knowledge that a material is in fact contaminated with this P-listed form, the material **SHALL** be considered hazardous waste.

4.3.1 Sample Types, Quantities and Methodologies

Consistent with the DOE graded-approach, buildings or rooms within buildings with a higher probability of contamination will have a higher number of samples taken within them, whereas buildings or rooms with less risk will have correspondingly fewer samples taken. The decision tree for Be sampling is shown in Figure 1, Beryllium Sampling Decision Tree. The sample requirements will depend on whether the area of interest is a beryllium area (i.e., Beryllium-Regulated Areas, Beryllium-Contaminated Areas, Beryllium Contamination within Internal Systems, or areas of known historical beryllium activity) or not.

If an area of interest is not within a beryllium area, as defined above, it must have adequate supporting historical/process knowledge before the area is concluded as not (Be) contaminated. A minimum of five (5) biased samples (smears), per area of interest, **SHALL** be acquired to characterize the area or building. Areas with the highest potential for Be contamination, which would serve as suitable locations for biased samples, include but are not limited to:

Figure 1. Beryllium Sampling Decision Tree.



Around or on equipment that could have processed Be;
Areas where Be waste could have been placed in containers, repacked, or bagged out;
Ventilation dead zones where settling of airborne materials could have occurred (e.g., horizontal surfaces of ductwork and hoods, light fixtures, rafters, and high ledges);
Areas along room exhaust paths including in front of room air exhaust filters;
Areas that are hidden or difficult to access and not normally cleaned, particularly areas between walls and equipment; and
Traffic areas traversed by Be workers.

If beryllium is detected ($\geq$0.1 μg/100 cm^2) in a non-beryllium area or in an area never designated as a beryllium area, random sampling **SHALL** be conducted as outlined below for beryllium areas or areas that were historically designated as beryllium areas.

Beryllium areas or areas that were historically designated as beryllium areas must also have adequate analytical data to support conclusions of no beryllium contamination. If historical data are not adequate, random sampling **SHALL** be conducted. Biased samples should also be taken at locations designated by IH.

The sampling technique **SHALL** depend upon the nature of the surface to be surveyed. Non-porous surfaces **SHALL** be sampled by swipe surveys as described in the Beryllium Characterization Procedure (PRO-536-BCPR). An area of 100 cm ^{2} **SHALL** be swiped using Whatman 41 filter papers or equivalent. The filter paper **SHALL** then be placed in a glassine bag. The surface sample number **SHALL** be written on the bag. Porous surfaces **SHALL** be sampled using a micro-vac technique as described in the Beryllium Characterization Procedure (PRO-536-BCPR). The sampling tool **SHALL** be a battery- powered air sampling pump with a 25 mm mixed cellulose ester filter media cassette attached. A section of Tygon tubing **SHALL** be attached to the upstream side of the cassette and facilitate pickup of all loose dust in the grid area. Each sample **SHALL** be documented as to location, and the cassette **SHALL** be labeled with an identifying number and sealed.

Intrusive media sampling (i.e., coring, scraping, etc.) for Be is not necessary unless the contamination is suspected to be a constituent of the material's matrix.

The sample number **SHALL** be documented on the chain-of-custody form. The sample location may be photographed with a sample photo identification card in the focus area documenting the sample number and date, and orienting the viewer to the sample location with an arrow.

Media potentially contaminated with beryllium **SHALL** be characterized using process knowledge and/or chemical analysis of smear samples. Samples **SHALL** be analyzed by EPA SW-846 methods (6010B, with total digestion by 3052, 3050B, or 3051 depending upon the matrix) or equivalent methods, such as OSHA Method 121 for flame atomic absorption spectroscopy, OSHA Method 125-G for inductively coupled plasma spectroscopy, or NIOSH 7104. An equivalent preparation method

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includes NIOSH Method 7300, modified for microwave digestion. The PQL **SHALL** be less than or equal to one half the beryllium investigation level of 0.1μg/100 cm^2, i.e., less than 0.05 μg/100 cm^2.

If any single measurement equals or exceeds the investigation level of 0.1μg/100 cm^2, but does not exceed 0.199 μg/100 cm^2, then a minimum of four additional biased measurements **SHALL** be acquired to characterize the area of interest. All measurements **SHALL** be compared with the unrestricted release level of 0.2 μg/100 cm^2. This allows for additional sampling at the discretion of sampling personnel to better define the potential for contamination. As an example, if more than one measurement exceeds the investigation level, then more than four additional biased measurements **SHALL** be acquired. If all measurements are less than the unrestricted release level, the area is considered non-beryllium contaminated. If any measurement equals or exceeds the unrestricted release limit of 0.2 μg/100 cm^2, further sampling **SHALL** be required to define the boundaries of contamination.

4.3.2 Statistical Basis for Random Samples

Given the sample size determined for a room, a set of randomly generated coordinates **SHALL** be used to locate each sample in the room. Coordinates **SHALL** be generated before sampling activities commence. Samples **SHALL** be taken in the indicated area on the horizontal surface(s) where Be could have settled. Each sample taken at a location **SHALL** be described in the sampling log with respect to both location and sample source (i.e., floor, table, glovebox, etc.) in such a way that it is uniquely identified for follow-up sampling if needed.

The total number of samples **SHALL** be determined by the size of the area. One sample **SHALL** be collected for every 100 square feet up to 1,000 square feet (or ten samples). No matter how small the room is, a minimum of five random samples **SHALL** be collected. An additional sample **SHALL** be collected for every additional 200 square feet over 1,000 square feet up to 5,000 square feet total, and then one additional sample for every 500 square feet with a maximum of 75 samples per area. For example, in a room with 200 square feet, 5 random samples **SHALL** be collected.

4.4 Polychlorinated Biphenyls (PCBs)

Historical data such as maintenance records, specifications, and emergency response documents **SHALL** be consulted to determine if PCBs or potentially PCB-containing items and materials were used in the area being characterized. Particular attention **SHALL** be paid to records of spills.

A physical tour of the building **SHALL** be conducted to identify any equipment potentially containing PCBs (e.g., electrical transformers, hydraulic systems, and PCB-containing ballasts in fluorescent lighting) and any evidence of spills or staining associated with the equipment (i.e., areas suspected of PCB contamination) **SHALL** be noted. A list **SHALL** be generated, along with estimated quantities. All painted surfaces **SHALL** be noted, including the color of paint and age of the facility to determine if surfaces are subject to regulations governing PCBs (i.e., the ban prohibiting the use of PCBs in manufacturing became effective in 1979). IH **SHALL** evaluate individually any situation involving sampling of PCBs or potential PCB-containing materials and **SHALL** ensure that proper worker protection is achieved.

4.4.1 Sample Types and Locations

Decisions as to whether sampling of various materials is required **SHALL** be based in part on the designated waste stream, in addition to IH concerns regarding worker safety. Federal regulations regarding characterization of a potential PCB waste stream are complex and are governed by the classification of the waste. A building walkdown **SHALL** be conducted to assess types of materials potentially containing PCBs, which include but are not limited to the following:

Hydraulic fluid
Oils
Transformers
Capacitors
Fluorescent light ballasts
Gaskets in potential PCB-containing systems
Paints, coatings, and sealants
Areas of a known or suspected PCB spill, or staining near a PCB-containing system.

Following the building walkdown, PCBs **SHALL** be categorized into the classifications outlined in subsequent sections. Where doubt exists as to the potential classification of a type of PCB-containing material, 40 CFR 761 should be consulted directly.

4.4.1.1 PCB Bulk Product Waste

Some materials may be classified as PCB Bulk Product Waste, which is defined by 40 CFR 761.3 as waste derived from manufactured products containing PCBs in a non-liquid state and at a concentration at time of designation for disposal of greater than or equal to 50 ppm. These materials need not be sampled as long as restrictions regarding their disposal are met, as outlined in 40 CFR 761.62. These materials and restrictions include but are not limited to:

- Applied dried paints, coatings, and sealants. These may be disposed of at a facility that is permitted, licensed or registered by a State to manage municipal solid waste subject to 40 CFR 258, or non-municipal, non-hazardous waste subject to 40 CFR 257.5 through 257.30.
- Fluorescent light ballasts containing PCBs in the potting material are segregated from those that do not, and both types of ballasts are sent offsite for recycling.

Concrete containing PCBs in paints is considered PCB Bulk Product Waste. However, EPA has approved on-site burial based on a risk-based analysis of hazards (letter from K. Clough, US EPA Region 8, to J. Legare, DOE RFFO, 8EPR-F, Approval of the Risk-Based Approach for Polychlorinated Biphenyls (PCB)-Based Painted Concrete).

4.4.1.2 PCB Remediation Waste

Buildings where PCB use occurred, but for which there are adequate inspection records, operational records, and administrative records that indicate no PCB spill has occurred, or if such did occur, was cleaned up to meet standards in 40 CFR 761, need not be sampled. In situations for which adequate information does not exist, a small-scale survey **SHALL** be performed, with three biased samples and a duplicate taken at locations biased toward probable contamination areas. In some situations involving relatively small areas (sumps, stains beneath a valve, etc.), the media can be adequately characterized by taking just one sample and a duplicate. For large areas, the number of "QC" samples should not exceed 10% of the "real" sample number.

If such surveys indicate PCB contamination, or if a PCB spill is discovered that has not been cleaned up, the area **SHALL** be treated as directed by 40 CFR 761. The Kaiser-Hill strategy for PCB remediation waste will be determined on a case-by-case basis in consultation with the LRA and EPA.

Process knowledge and historical documentation are vital for this process, since decision thresholds vary depending upon the date of the spill. For example, the criteria for PCB remediation waste (i.e., potentially containing PCBs from historical releases; defined by 40 CFR 761.3), include:

Materials where the original source was ≥ 500 ppm PCB beginning on April 18, 1978, or ≥ 50 ppm PCB beginning on July 2, 1979;
Materials disposed of prior to April 18, 1978, that are currently ≥ 50 ppm PCBs regardless of the concentration of the original spill.

If random sampling is warranted, sampling of the area may include application of the Midwest Research Institute grid procedure described in *Verification of PCB Spill Cleanup by Sampling and Analysis* (EPA-560/5-85-026) and *Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup* (EPA-560/5-86-017).

The number of samples required by the Midwest Research Institute grid procedure depends upon the size of the spill area, and the documents above should be consulted for exact requirements concerning hexagonal grid designs, layout for irregularly shaped areas, number and spacing of samples, etc. In general, for a sampling area of ≤ 50 ft^2, 7 samples are required; for 51 to 400 ft^2, 19 samples are required; and for > 400 ft^2, 37 samples are required.

Additionally, for purposes of decontamination or removal, PCB remediation waste **SHALL** be further categorized into: non-porous surfaces, porous surfaces, liquid, and bulk PCB remediation waste (which includes soil and sludge and is not to be confused with PCB bulk product waste), as per 40 CFR 761.61.

4.4.1.3 PCB Items

A PCB Item is defined as any PCB Article, PCB Article Container, PCB Container, PCB Equipment, or anything that deliberately or unintentionally contains or has as a part of it any PCBs, and includes transformers and capacitors. If encountered during PDS, these items **SHALL** be characterized prior to removal based upon the PCB content detected in the dielectric fluid, or on results from surface swipes, or by process knowledge.

4.4.1.4 Other PCB Wastes

While less likely to be encountered during PDS, other classes of PCB waste exist and **SHALL** be recognized if encountered, for example:

- PCB liquids include PCB-containing transformer oils and hydraulic oils. If encountered, the PCB concentration **SHALL** be determined prior to disposal per 40 CFR 761.50 and 761.60.

- PCB radioactive waste refers to PCBs that also contain source, special nuclear, or byproduct material subject to regulation under the Atomic Energy Act of 1954, as amended, or naturally-occurring or accelerator-produced radioactive material. This waste **SHALL** be managed in accordance with 40 CFR 761 per the requirements of the specific category of radioactive waste.

4.4.2 Sampling and Analysis Methodologies

The following sampling techniques **SHALL** generally be applied to PCB sampling, subject to stipulations in 40 CFR 761. The EPA documents *Verification of PCB Spill Cleanup by Sampling and Analysis* (EPA-560/5-85-026) and *Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup* (EPA-560/5-86-017) should be consulted in detail before any sampling begins. A subject matter expert should be consulted before any PCB sampling is initiated.

For non-porous surfaces, wipe sampling will be carried out as described in the *Metals and PCB Characterization Procedure* (PRO-487-MPCR).
For porous surfaces into which a PCB spill could migrate, sampling will be carried out as described in the *Metals and PCB Characterization Procedure* (PRO-488-BLCR).

The analytical method **SHALL** have a practical quantitation limit (PQL) of less than 50% of the regulatory threshold which applies to the particular type of waste. EPA SW-846 Methods 4020 and 8082 satisfy this criterion.

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4.5 Asbestos

A Colorado Certified Asbestos Inspector **SHALL** identify all homogenous areas of friable and non-friable suspected asbestos containing building material (ACBM), and sample those areas not assumed to be ACBM per 40 CFR 763.85 though 763.87 and 5 CCR 1001 – 10 (Regulation 8). The presence of asbestos (i.e., greater than 1% by volume, weight or area) **SHALL** be determined by a certified laboratory with asbestos accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) using EPA Method 600/R-93/116, a polarized light microscopy (PLM) technique. Point counting will be required when PLM results range between trace and 1%. All analytical and quality specifications associated with the analysis are contained in Kaiser-Hill Analytical Services Division Statement of Work, Industrial Hygiene, Asbestos Module IH02.

Building records (e.g., blueprints and specifications) will be consulted to document use of asbestos in construction or remodeling of the building under characterization. Maintenance and asbestos abatement records, blueprints, as-built drawings, specifications, and emergency response documents are examples of the data used.

A physical tour of the building **SHALL** be conducted, and notation made of suspect or affected materials that indicate through either historical data or the asbestos inspector's experience the presence of asbestos in building materials. A list **SHALL** be generated that includes estimated quantities. A Certified Asbestos Inspector may assume that a material is asbestos until proven otherwise.

4.5.1 Sample Types and Locations

Sample locations **SHALL** be selected randomly according to how each represents a homogeneous material. Since homogeneous areas are located throughout the building, the representation and number of samples is the driving factor rather than the exact location of the sample in each room. The generic categories of materials to be sampled for asbestos are listed below:

Thermal systems (e.g., pipe insulation)
Walls (that may be transite)
Surfacing materials (e.g., fireproofing and ceiling texture)
Miscellaneous (e.g., floor tiles, ceiling panels, mastic and caulking).

Non-suspect (or unaffected) materials are those traditionally made of wood, glass or metal. However, the inspector **SHALL** suspect the adhesives that have been applied to secure non-suspect materials to the substrate.

The number of asbestos samples to be collected for each homogeneous area is outlined in EPA 40 CFR 763.86. This section of the Asbestos Hazard Emergency Response Act (AHERA) provides requirements for asbestos building inspections. Sample quantity **SHALL** be decided first by a material's physical condition of friability, then by its general category. Friable materials are those that are capable of being crumbled or reduced to powder by hand pressure.

Thermal systems insulation, such as that found on pipes or ducts, friable or non-friable, requires a minimum of three samples per homogeneous area, one sample from patches less than six linear or square feet (lf or ft^2), and one from cementitious or "mudded" fittings. Each mechanical system, such as hot and cold domestic water, may have several homogeneous areas. Each **SHALL** be sampled accordingly.

When friable surfacing materials (troweled-on ceiling texture or sprayed-on fireproofing) are tested for asbestos, a sampling grid **SHALL** be utilized. Such sampling **SHALL** involve a nine-section grid applied to a blueprint of the area, and samples **SHALL** be acquired from the center of randomly selected grids. If the homogeneous area of friable surfacing material is less than 1,000 ft^2, three samples are needed; if between 1,000 and 5,000 ft^2, five samples are needed; and if the area is over 5,000 ft^2, seven samples are needed.

Miscellaneous materials, such as floor and ceiling tiles or cementitious board ("Transite") will be sampled according to the inspector's discretion, as outlined in 40 CFR 763.86 (c&d). For the purpose of this survey and based on the inspector's experience and discretion, a minimum of one sample of each suspected material in this category **SHALL** be acquired.

Sampling for asbestos in building materials is a destructive method that may release a small quantity of dust. Although material samples are to be collected from inconspicuous areas, proper safety precautions **SHALL** be taken to prevent the spread of suspect materials.

Settled dust sampling for asbestos will be used as an optional aid to assessment of IH issues such as work practices, engineering controls, and PPE that would be used in the decommissioning, removal or demolition of structures.

4.5.2 Sampling Methodologies

Bulk sampling for asbestos **SHALL** be performed as described in the *Asbestos Characterization Procedure* (PRO-563-ACPR) using destructive techniques, and requires the acquisition of a representative sample of the material down to the substrate. Each sample **SHALL** contain a minimum of one cubic centimeter of material to facilitate analysis and archival processes. Each sample should be acquired with the intent of assuring the quality, representativeness and safety of the process.

For bulk sampling, a polyethylene drop cloth or plastic bag **SHALL** be placed below the elevated sample areas, and the immediate sample area **SHALL** be dampened with a mist of water and surfactant. A sampling tool, such as a hammer and chisel, razor knife, or hole saw is selected, and the sample is collected down to the level of the substrate. During this process, the immediate surface **SHALL** be misted as necessary.

The acquired sample **SHALL** be placed in a sealable container, the container **SHALL** be sealed, and a pre-numbered label **SHALL** be placed on the container. The sample number label **SHALL** be placed on chain-of-custody papers, and the container **SHALL** be verified to be sealed. The sampling tool **SHALL** be thoroughly cleaned using a mister and wipes per AHERA, and the sample area **SHALL** be patched as needed.

The description and location **SHALL** be documented on a form, a sample label **SHALL** be placed on the form, and the location **SHALL** be documented on a blueprint, sketch or drawing of the area. The sample container, drop cloth, and immediate sample area **SHALL** be wet wiped, and the drop cloth **SHALL** be carefully folded into the center and placed in a bag, and the bag **SHALL** be sealed.

In the case of routine maintenance areas, a pre-numbered label **SHALL** be placed at the sample location. Labels may be placed on all sample locations. The sample location may be photographed with a sample photo identification card in the focus area documenting the sample number and date, and orienting the viewer to the location with an arrow. All used wipes, drop cloths, and PPE **SHALL** be added to the appropriate waste stream.

Settled dust sampling on horizontal surfaces **SHALL** be sampled as described in the *Asbestos Characterization Procedure* (PRO-563-ACPR) using a micro-vac technique. The sampling tool is a low volume battery powered air sampling pump calibrated at >2 liters per minute with a 25 mm MCE filter media cassette attached. A two-inch section of Tygon tubing is attached to the upstream side of the cassette and facilitates pickup of all loose dust in the grid area. Each sample **SHALL** be documented as to location, and the cassette **SHALL** be labeled with an identifying number and sealed. The sample number **SHALL** be documented on the chain-of-custody form. As above, the sample location may be photographed with a sample photo identification card in the focus area documenting the sample number and date, and orienting the viewer to the sample location with an arrow.

5.0 RADIOLOGICAL FIELD INSTRUMENTATION

The radiation detection instrumentation to be utilized for the PDS **SHALL** provide adequate sensitivity to demonstrate compliance with the release criteria. Other considerations in selecting instrumentation **SHALL** include instrument performance under the expected range of environmental conditions, instrument durability, and survey time requirements.

5.1 Minimum Detectable Concentration Calculation

The Minimum Detectable Concentration (MDC) is the *a priori* net activity level above the critical level that an instrument can be expected to detect 95% of the time, in units consistent with the release criteria (e.g., dpm/100 cm^2).

The MARSSIM recommends selecting measurement systems with an MDC between 10-50% of the $DCGL_W$ (for static measurements), with the recognition that this will not always be achievable based on available technology and budget constraints.

The instruments currently utilized at RFETS to assess the average contamination levels in a survey unit have been demonstrated to achieve an *a priori* MDC of less than 50% of the $DCGL_W$ for surface contamination measurements and laboratory analysis. A table of the most commonly utilized detectors, associated parameters, and the resulting *a priori* MDC, is provided below:

Measurement Type	Detector Model	Bkg Count Rate (cpm)	Bkg Count Time (m)	Sample Count Time (m)	Efficiency (c/d)	MDC (dpm/100 cm^2)
Alpha Direct (Static)	NE Electra DP6	4	1.5	1.5	0.20	48
Removable	SAC-4	0.6	10	2	0.33	10

Other instruments utilized for PDS should demonstrate the capability of achieving an *a priori* MDC of less than 50% of the associated $DCGL_W$ (averaged over a one square meter area). While recognizing that this is not always achievable, every reasonable effort **SHALL** be implemented in order to meet this requirement (e.g., increase count time, decrease source-to-detector distance, etc.). Any deviations from this guidance **SHALL** be discussed with the LRA. A justification will also be provided in the PDSR for instrumentation that cannot achieve an MDC of less than 50% of the associated $DCGL_W$.

A posterior MDCs will not typically be calculated, given that those data do not provide any net benefit when an *a priori* assessment of MDC has already been performed for a specific detection system.

5.1.1 Direct Measurement MDCs

The MDC values for static field instruments **SHALL** be calculated using the following equation, per NUREG-1507 Equation 3-11 (note that the E_T term represents a 4π routine calibration):

$$MDC = \frac{3 + 3.29\sqrt{R_b t_s (1 + \frac{t_s}{t_b})}}{E_T (A/100) t_s}$$

R_b = background counting rate
t_s = sample counting time interval
t_b = background counting time
E_T = total efficiency
A = physical surface area of the detector (or the area sampled for smears)

5.1.2 Scan Measurement MDCs

The instrument utilized for scan surveys at RFETS should typically achieve an MDC level of ≤ $DCGL_{EMC}$ (or applicable investigation action level, whichever is lower). An instrument that is capable of detecting contamination levels of ≤ $DCGL_W$ (e.g., position-sensitive proportional detector) would preclude the need for static measurements and statistical tests, provided that a 100% scan of the survey unit is performed (or all randomly-selected locations are scanned).

The detection sensitivity can be improved by varying one of the following factors:
1) Higher instrument detection efficiency
2) Lower background
3) Decreased scan speed
4) Increased size of effective probe area (without a significant increase in background response)

5.1.2.1 Alpha Scans

The typical detection sensitivity calculations cannot be applied to alpha-emitters because the background is generally close to zero. Therefore, the probability of detecting given levels of alpha surface contamination is calculated by the use of Poisson summation statistics.

Given a known scan rate and a surface contamination DCGL, the probability of detecting a single count while passing over the contaminated area, per MARSSIM Equation 6-12 is:

$$P(n \geq 1) = 1 - e^{\frac{-GE_T d}{60v}}$$

P(n≥1)=		probability of observing a single count
G	=	contamination activity (dpm)
E_T	=	total efficiency
d	=	width of detector in direction of scan
v	=	scan speed (cm/s)

Once a count is recorded and the guideline level of contamination is present, the surveyor should stop and wait until the probability of getting another count is at least 90% (MARSSIM, p. 6-48). The time interval is calculated by MARSSIM Equation 6-13:

$$t = \frac{13,800}{CAE_T}$$

t	=	time period for static count (s)
C	=	release criteria (dpm/100 cm^2)
A	=	physical probe area (cm^2)
E_T	=	total efficiency

Some instruments (e.g. portable proportional detectors) may have background count rates on the order of 5 to 10 cpm. Thus, it would not be practical to require a surveyor to respond to a single observed count. For these instruments, the probability of getting two or more counts can be calculated by MARSSIM Equation 6-14:

$$P(n \geq 2) = 1 - \left(1 + \frac{(GE_T + B)t}{60}\right)\left(e^{\frac{-(GE_T + B)t}{60}}\right)$$

P(n≥2)	=	probability of getting 2 or more counts during the time interval t
B	=	background count rate (cpm)

All other variables are the same as for MARSSIM Equation 6-12.

The selected probability of detection (MARSSIM equation 6-12) should be ≥ 67%, based on ANSI N13.12, "Control of Radioactive Surface Contamination on Materials, Equipment, and Facilities to be Released for Uncontrolled Use." This ANSI standard recommends a probability of detection of 50 to 67%. For final survey purposes, the more conservative value of 67% is warranted.

5.1.2.2 Beta Scans

The MDC for the scanning of beta emitters is calculated based on signal detection theory, which provides a framework for the task of deciding whether the audible output of the survey meter during scanning is due to background or signal plus background levels.

The scan MDC is based on several factors, including observation interval, the index of sensitivity, background count rate, surveyor efficiency, and detector efficiency.

The index of sensitivity (d') represents the distance between the mean of the background and the background plus signal. This value is calculated based on a specified decision error. As recommended by MARSSIM (Page 6-39), a high rate of correct detection (95%) is required for PDS, and a high rate of false positives (60%) is tolerated. Thus, the associated index of sensitivity is 1.38.

The observation interval (i), which represents the time that a typical source remains under the probe during scanning, can be calculated based on the probe width (cm), scan rate (cm/s), and assumed source size. For example, the observation interval for a scan performed at a rate of 5 cm/s with a DP6BD probe (width of ~ 8 cm), assuming a point source, is approximately 1.6 s (8 cm ÷ 5 cm/s).

Thus, the minimum number of source counts in the interval (s_i) is calculated per the following equation:

$$s_i = d'\sqrt{b_i}$$

d' = index of sensitivity (1.38)
b_i = observed background counts in interval i

This value can then be converted to a minimum detectable count rate (MDCR) per the following equation:

$$MDCR = s_i \times (60/i)$$

MDCR= minimum detectable count rate (cpm)
i = observation interval (s)

The scan MDC (in dpm/100 cm^2) can then be calculated as follows:

$$Scan\ MDC = \frac{MDCR}{\sqrt{p}\ \varepsilon_T\ \frac{probe\,area}{100cm^2}}$$

MDCR = minimum detectable count rate
ε_T = total efficiency
p = surveyor efficiency (recommended value = 0.5, unless otherwise empirically proven).

5.2 Calibration and Maintenance

5.2.1 General Requirements

Calibration refers to the comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustments.

At a minimum, each measurement system should be calibrated annually and response checked with a source following calibration (ANSI 1996). More frequent calibrations may be required if recommended by the manufacturer. Re-calibration of an instrument would be required under the following conditions:

Instrument repair or modification that could affect the response
Failure of a performance check not associated with identifiable factors (e.g. loss of purge of a gas-flow detector)

The calibration program for a given instrument **SHALL** be developed and documented in accordance with an approved industry standard (e.g., ANSI 1978, ANSI 1989, ANSI 1997, DOE Order 5481.1). Instrument manufacturers or vendors who perform their own calibrations should be evaluated to assure that minimum requirements are met.

Calibration sources should be traceable to the National Institute of Standards and Technology (NIST). For situations where NIST traceable sources are not available (e.g. high activity transuranic sources), standards obtained from other industry-recognized sources (e.g., New Brunswick Laboratory) may be used.

5.2.2 Efficiency Determinations

The calibration of instruments **SHALL** be performed such that a direct measurement can be accurately converted to the 4π (total) emission rate from the source

(MARSSIM, p. 6-23). The factors that should be considered for during calibration and survey include the following:

Decay scheme of source
Geometry
Energy
Backscatter
Self-absorption

Note that factors such as self-absorption can be minimized in the field by maintaining a clean and smooth surface. In addition, the collection of smears and surface media samples in areas that exhibit surface degradation provides further justification that contamination is not being attenuated.

5.2.3 Gamma Detection Instruments

Although not required to demonstrate compliance with the release criteria, gamma measurements may be performed to support investigations during the PDS. The calibration of such detectors should also provide reasonable assurance of acceptable accuracy in field measurements. Thus, applicable ANSI (or other approved industry standard) standards should be applied and documented in corresponding Radiation Safety Practices (RSP) or Technical Basis Documents.

For energy-dependent gamma-scintillation instruments (e.g. NaI(Tl) detectors), calibration for the gamma energy spectrum at a specific site may be accomplished by comparison with a pressurized ionization chamber (or equivalent) at different locations, or by use of multiple radionuclides of various photon energies.

In situ gamma spectroscopy may also be performed to fulfill the minimum requirements for total surface contamination (TSC) measurements, media samples, and scan surveys outlined in this plan (refer to Section 3.0).

5.2.4 Instrument Maintenance

5.2.4.1 Performance Checks

Instruments utilized for PDS **SHALL** receive performance checks prior to and following use, typically prior to beginning the day's measurements and again following the conclusion of measurements on the same day. The performance check criteria is typically established following calibration by placing the source in a fixed, reproducible location and recording the instrument reading. A series of source and background readings (10 or more of each type) are collected in this manner, and the average and standard deviation of each data set are recorded. The daily performance checks **SHALL** fall within ± 20% of this established range to be considered acceptable for use.

If during a performance check an instrument does not fall within the established range, the instrument **SHALL** be removed from service until the reason for the deviation can be identified and corrected.

5.2.5 Field Handling and Control

Instruments **SHALL** be handled in accordance with prescribed limitations and conditions of use, as described in the corresponding instrument procedures. Any deviation from normal use **SHALL** be documented on the survey forms and evaluated during data assessment.

6.0 LABORATORY ANALYSIS

Analysis of PDS samples **SHALL** be performed by laboratories contracted by RFETS Analytical Services Division. Laboratories **SHALL** perform work pursuant to requirements presented in the RFETS Statement of Work (SOW) for Analytical Measurements. This SOW defines requirements for the analysis of various parameters, including radiochemical, organic and metal, in samples collected at or related to the site. The SOW is composed of several modules. The General Laboratory Requirements Module, GR01, provides general technical and administrative requirements common to all analyses performed for the site. The General Requirements for Electronic Data Deliverables Module, GR02, provides requirements for the electronic delivery of data. Other SOW modules provide parameter-specific analytical, quality assurance/quality control, reporting, and general requirements specific to stated analytical tasks.

Where possible, SOW modules incorporate industry standard methods and protocols by reference. In some cases, requirements in these referenced methods are augmented or clarified by SOW modules. Typical references include EPA Contract Laboratory Program Statements of Work, EPA Test Methods for Evaluating Solid Waste (SW-846; EPA 1986), EPA methods for wastewater monitoring, and ASTM methods.

7.0 DATA ANALYSIS AND QUALITY ASSESSMENT

Radiological data **SHALL** first be reduced to perform comparisons with radiological limits and statistical tests (if applicable). The quality of this transformed data then **SHALL** be assessed to assure that the data can be used for the Pre-Demolition Survey (PDS).

There are three types of radiological surveys/samples that will be discussed in this section: removable surface contamination (RSC) surveys, total surface contamination (TSC) surveys, and media samples. Further discussion on how radiological survey and media sample results are transformed from a gross instrument count to a net activity that can be used for comparisons with radiological limits is provided in PRO-478-RSP-16.04, Radiological Survey/Sample Data Analysis.

The radiological limits or Derived Concentration Guideline Levels ($DCGL_W$) **SHALL** then be delineated for both surface contamination surveys and media samples. The $DCGL_W$ is the maximum allowable contamination level AVERAGED over a one square meter area. The $DCGL_{EMC}$ is the maximum allowable contamination level limited to any 100 cm^2 area (refer to Table 7-1).

General descriptions of data validation, data verification, data quality indicators and data quality assessment are provided in Section 7.3. Further guidance is provided in PRO-478-RSP-16.04, Radiological Survey/Sample Data Analysis.

Data reduction and analysis for non-radiological data remains consistent with the DDCP; no additional requirements apply during to the pre-demolition survey.

7.1 Conversion of Radiological Measurements to Reporting Units

Radiological survey/sample results **SHALL** be converted from a gross count to a net concentration for the purpose of comparing with radiological limits. For surface contamination surveys, the radiological limits are prescribed in dpm/100cm^2. For media samples, the radiological limits are based on a surface contamination limit in dpm/100 cm^2.

The data conversion for surface contamination (total and removable) measurements **SHALL** be performed in accordance with PRO-476-RSP 16.02, Radiological Surveys of Surfaces and Structures. The data conversion for samples **SHALL** be performed in accordance with PRO-477-RSP 16.03, Radiological Samples of Building Media.

7.1.1 Removable Surface Contamination

Removable surface contamination (RSC) results **SHALL** be compared with an RSC limit ($DCGL_W$) that has the units of dpm/100 cm^2. RSC **SHALL** be measured in the field using a swipe technique that assesses the amount of loose radiological contamination over a 100-cm^2 area. Swipes may be counted for alpha and/or beta-

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gamma-emitting radioactive material depending on the results of the reconnaissance level and in-process surveys. Swipes **SHALL** be counted using portable or fixed counting equipment to see how much loose radioactive material is transferred to the swipe. The RSC net result **SHALL** be calculated per RSP 16.02.

7.1.2 Total Surface Contamination

Total Surface Contamination (TSC) results **SHALL** be compared with a TSC limit that has the units of dpm/100 cm^2. Total surface contamination **SHALL** be measured in the field using portable radiation detection instrumentation. The probe from this instrumentation is placed on an area where radioactive material may be present. Alpha and/or beta-gamma-emitting radioactive material may be counted depending on the results of the reconnaissance level and in-process surveys.

The Local Area Background (LAB) **SHALL** be subtracted from the instrument gross count rate. This subtraction is necessary since the surface contamination limits apply to the radioactive material present above background. If background were not subtracted from the instrument net count rate, the instrument gross count rate would be an overestimate of the amount of DOE-added radioactive material present.

If a beta/gamma survey is performed which has Naturally Occurring Radioactive Material (NORM) present, then an additional option exists in which a statistically based background value is determined (per PRO-480-16.06, Radiological Background Determination). This average background can then also be subtracted from the gross data result. The total surface contamination result **SHALL** be calculated per RSP 16.02.

7.1.3 Media Contamination

Media contamination sample results **SHALL** be compared against the surface contamination limits, and the results **SHALL** be reported in pCi/gram (by laboratory) and dpm/100 cm^2 (for data analysis).

If the data result for the media being analyzed indicates the presence of NORM that is also a site contaminant of concern (e.g. U-238), then an additional comparison option exists in which a statistically based background value is determined (refer to PRO-480-16.06, Radiological Background Determination)

7.2 Comparison with Radiological Limits

The comparison of the measurement results against the DCGL values, as described in this section, **SHALL** provide the basis for releasing building structures as sanitary waste or as unrestricted release. The conclusions reached during the PDS **SHALL** be used to remove/dispose of building structure materials.

7.2.1 Surface and Media Contamination Limits

The $DCGL_W$ (Average Derived Concentration Guideline Level) and the $DCGL_{EMC}$ (Maximum Derived Concentration Guideline Level) limits are based on the requirements in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." Surface contamination limits are based on Figure 7-1, "Surface Contamination Guidelines" from DOE Order 5400.5 as amended by DOE Memorandum entitled *Application of DOE 5400.5 requirements for release and control of property containing residual radioactive material*, dated 11/17/95. The surface contamination limits that **SHALL** be used at RFETS are provided in Table 7-1.Media sample limits **SHALL** be based on the surface contamination limits in dpm/100 cm^2.

7.2.2 Comparison With Surface Contamination Limits

To compare the survey result with the $DCGL_W$, the identity of the radionuclides in an area **SHALL** be known. The applicable "average total", "maximum total" and "removable" surface contamination limits **SHALL** then be identified in Table 7-1 These surface contamination limits **SHALL** be used for all total surface contamination (TSC) and removable surface contamination (RSC) survey points. Both TSC and RSC survey results **SHALL** be assessed to disposition an area.

At each survey point, the survey result for total contamination **SHALL** be compared directly with the average TSC $DCGL_W$ (or the applicable investigation action level, as described in Tables 3-1 and 3-2) . If all survey results are below the $DCGL_W$, the area may be categorized as sanitary waste or releasable without restrictions. If any survey result is greater than the $DCGL_{EMC}$, the affected area may be decontaminated. In addition, if any single measurement exceeds the $DCGL_W$, the applicable MARSSIM statistical test (typically the Sign Test) **SHALL** be performed on the original survey results to demonstrate that the average contamination level over the survey unit is less than the $DCGL_W$. Other requirements may apply for Class 3 areas (refer to Section 3.1.2.8). Decontaminated areas **SHALL** be re-surveyed before the PDS can be completed.

At each survey point, the survey result for removable surface contamination (RSC) **SHALL** be compared directly with the RSC $DCGL_W$. If all survey results are below the $DCGL_W$, the area may be categorized as sanitary waste or releasable without restrictions. If any survey result is greater than the $DCGL_W$, the area around that survey location may be decontaminated, and the survey unit evaluated for other areas of potential contamination (refer to Section 3.1.2.8 for additional requirements). Decontaminated areas **SHALL** be re-surveyed before the PDS can be completed.

Table 7-1 Surface Contamination Guidelines

Radionuclides [2]	Total Average [3/ 4/] (dpm/100 cm^2) [1/] ($DCGL_w$)	Total Maximum [4/ 5/] (dpm/100 cm^2) ($DCGL_{emc}$)	Removable [4/ 6/] (dpm/100 cm^2) ($DCGL_w$)
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	100	300	20
Th-Natural, Sr-90, I-126, I-131, Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-Natural, U-235, U-238 and associated decay products, alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above. [5]	5,000	15,000	1,000
Tritium (applicable to surface and subsurface. [6]	Not Applicable	Not Applicable	10,000

1/ As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

2/ Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

3/ Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

4/ The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

5/ The maximum contamination level applies to an area of not more than 100 cm^2. DOE 5400.5 Chg 2 IV-7

6/ The amount of removable material per 100cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.

7/ This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

7.2.3 Comparison with Sample Contamination Limits

Sample (media) results **SHALL** be converted to dpm/100 cm^2. The comparisons described for total surface contamination (TSC) in Section 7.2.3 **SHALL** then apply.

7.3 Data Assessment

An assessment of the data collected during PDS **SHALL** be performed to ensure that the data satisfies the objectives of the PDS. The assessment involves three phases: verification, validation, and data quality assessment (DQA).

7.3.1 Data Verification

Data verification ensures that the requirements stated in the planning documents (*e.g.*, Pre-Demolition Survey Plan, Radiation Safety Practices procedures) are implemented as prescribed. Radiological survey/sample data obtained to support the PDS **SHALL** be verified to ensure that the PDSP requirements and RSP requirements have been met. Any deficiencies or problems that occurred during implementation **SHALL** be documented and reported. In addition, analytical and radiochemical samples **SHALL** be subject to the following reviews:

Chain-of-Custody was implemented during sampling and analysis.
Preservation and hold-times were within tolerance.

7.3.2 Data Validation

Data validation activities ensure that the results of data collection activities support the objectives of the PDS, or support a determination that these objectives should be modified. Data Usability is the process of ensuring or determining whether the quality of the data produced meets the intended use of the data. Data verification compares the collected data with the prescribed activities documented in the PDSP and the Radiological Safety Practices procedures. Data validation is often defined by six data descriptors:

1) Reports to decision maker
2) Documentation
3) Data sources
4) Analytical method and detection limit
5) Data review
6) Data quality indicators

The decision maker or reviewer **SHALL** examine the data, documentation, and reports for each of the six data descriptors to determine if performance is within the limits specified in the PDSP developed during survey planning. Data collected **SHALL** meet performance objectives for each data descriptor. If they do not, deviations **SHALL** be noted and any necessary corrective action performed. Corrective action **SHALL** be taken to improve data usability when performance fails to meet objectives.

Formal validation of radiological survey/sample data **SHALL** be performed at the following frequencies:

- ≤ 20 surveys/samples – 100%
- > 20 surveys/samples - 25%

7.3.2.1 Reports to Decision Maker

The cognizant individuals who will be performing the D&D planning, including decontamination methods, schedules, budgets, etc., **SHALL** be appropriately informed on the previous and current status of the area being characterized.

7.3.2.2 Documentation

The documents to be assessed **SHALL** include the completed radiological PDS survey package and non-radiological characterization package, including the completed radiological survey forms and results, the final radiological sample data, non-radiological data, data handling records (e.g., chain-of-custody forms), and supporting documentation.

7.3.2.3 Data Sources

Data source assessment involves the evaluation and use of historical analytical data. Historical analytical data **SHALL** be evaluated for use before PDS surveys/samples are obtained. The use of historical analytical data **SHALL** be evaluated with respect to PDSP requirements.

7.3.2.4 Analytical Method and Detection Limit

The selection of appropriate analytical methods based on detection limits is important to survey/sample planning. The detection limit of the method directly affects the usability of the data because results near the detection limit have a greater possibility of false negatives and false positives. Results near the detection limit have increased measurement uncertainty. All reported PDS data **SHALL** provide or reference the basis for the calculated detection limit (MDC or equivalent).

For the radiological PDS surface contamination surveys, the *a priori* detection limit **SHALL** be less than or equal to 50% of the $DCGL_W$ (refer to Section 5.1).

For the radiological PDS samples, sample analysis **SHALL** be performed as specified in Statement of Work for Analytical Measurements modules, including GR01-B.2, "General Laboratory Requirements"; RC04-B.1, "Gross Alpha and Gross Beta Analysis by Gas Flow Proportional Counting (GPC)"; and other Analytical Services Division documents, as applicable.

For non-radiological instruments, practical quantitation limits (PQLs) **SHALL** be provided (based on formal PQL studies) with all results. PQLs **SHALL** be less than half the associated action level. Detection limits for non-radiological samples are described in the RFETS Statement of Work for Analytical Measurements.

7.3.2.5 Data Review

Data review **SHALL** begin with an assessment of the quality of the radiological survey/sample data and **SHALL** be performed by a professional with knowledge of the PDS, MARSSIM and applicable Radiological Safety Practices procedures. All radiological and non-radiological survey/sample data **SHALL** be reviewed.

7.3.2.6 Data Quality Indicators

The assessment of data quality indicators is significant to determine data usability. The principal data quality indicators are precision, bias, accuracy, representativeness, comparability, and completeness (PARCC). Of the six principal data quality indicators, precision and bias are quantitative measures, representativeness and comparability are qualitative, completeness is a combination of both qualitative and quantitative measures, and accuracy is a combination of precision and bias.

A complete PARCC analysis is **SHALL** be conducted for radiological surveys/samples at the PDS stage. The intent of this section is to describe each data quality indicator, and provide examples of how each indicator is measured. The requirements for each PDS **SHALL** be provided in the individual PDS survey packages. For radiological constituents, PRO-475-RSP 16.01, Radiological Survey/Sampling Package Design, Preparation, Control, Implementation and Closure, **SHALL** be used to develop survey packages.

7.3.2.6.1 Precision

Precision is a measure of agreement among replicate measurements of the same property under prescribed similar conditions. The two basic activities performed in the assessment of precision are estimating the radionuclide concentration variability from the measurement locations and estimating the measurement error attributable to the data collection process. Precision can be measured through the following sample types:

1) Lab Replicates
2) MS Duplicates
3) Field Duplicates
4) Field Replicates (for scanning and direct measurements)

Refer to PRO-479-RSP 16.05, "Radiological Survey/Sample Quality Control" and Section 9.0 of this plan for further guidance.

Precision of laboratory data can be quantified by at least two functions. The most typical measure for non-radiological analyses is the relative percent difference (RPD) term, whereas, because of the stochastic nature of radioactivity, a statistical measure is better suited for evaluating radiological reproducibility. This measure is referred to as the duplicate error ratio (DER). The equations for evaluating these two measures is provided below:

$$RPD = \frac{C_1 - C_2}{(C_1 + C_2)/2} * 100$$

C_1 = first sample result (in terms of concentration)
C_2 = duplicate sample result (in terms of concentration)

$$DER = \frac{C_1 - C_2}{(TPU^2_{c1} + TPU^2_{c2})} * 100$$

C_1 = first sample result (in terms of concentration)
C_2 = duplicate sample result (in terms of concentration)
TPU = total propagated uncertainty

7.3.2.6.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Bias can be measured through the following samples or methods:

Analytical spike samples.
Field replicates (for scanning and direct measurements)
Performance checks tracked with a control chart

For radiological surveys/samples taken to support the PDS, laboratory replicates and field duplicates **SHALL** be analyzed to assess bias. Bias also **SHALL** be assessed through daily performance checks performed on radiological survey instruments. Laboratory replicates, field duplicates and performance checks **SHALL** be taken per the requirements in RSP 16.05, "Radiological Survey/Sample Quality Control."

7.3.2.6.3 Accuracy

Accuracy is a measure of the closeness of an individual measurement or the average of a number of measurements to the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that result from performing measurements. To be accurate, data must be both precise and unbiased. The accuracy of radiological surveys and sample analysis **SHALL** be assessed. Accuracy can be measured through the following samples or methods:

- Calibrations
- Lab control samples/spikes (LCS)
- Matrix Spikes (MS)
- Relative Standard Deviation (% RSD)

- Blanks
- Chemical yields (rads)
- Counting time (rads)
- Sensor Efficiency (rads)
- Correction for ingrowth daughters (rads)

Generally, the accuracy of radiological surveys **SHALL** be based on annual calibrations of instrumentation and daily source checks that perform within specified tolerances (e.g. +/- 20%), as specified in the Radiological Safety Practices (RSP). The accuracy of radiological surveys/samples also **SHALL** be based on the analysis of replicates and duplicates. Novel or prototypical instrumentation **SHALL** also demonstrate compliance with the specified tolerances in the RSPs.

7.3.2.6.4 Representativeness

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point. Representativeness is a qualitative term that should be evaluated to determine whether surveys/samples are collected in such a manner that the resulting data appropriately reflect the contamination present.

For the PDS, representativeness **SHALL** be assessed by assuring that the survey/sample location requirements of the PDSP and RSP 16.01 have been met. The surveys/samples obtained during the PDS **SHALL** be compared with the survey/sample location requirements in the PDSP and RSP 16.01. The impact of any discrepancies between the location of required versus actual surveys/samples **SHALL** be assessed.

7.3.2.6.5 Comparability

Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis. Differences in data sets **SHALL** be evaluated to ensure that the data sets can be used for a common goal. If historical data will be used to support the PDS, the historical data **SHALL** be assessed with respect to current data requirements in the PDSP and RSP 16.01. The comparability of the historical data set with the current data requirements **SHALL** be assessed before the PDS is performed.

All data collected to support the PDS **SHALL** be collected per Radiological Safety Practices procedures or other approved procedures (for non-radiological sampling) and will therefore be comparable. The comparability of all surveys/samples to support the PDS **SHALL** be assessed.

7.3.2.6.6 Completeness

Completeness is a measure of the amount of valid data obtained from the measurement system, expressed as a percentage of the number of valid measurements that should have been collected. Completeness is therefore a measure of the number of radiological surveys/samples obtained versus the number of radiological surveys/samples required per the PDSP and RSP 16.01.

90% of the required survey data are needed to meet completeness requirements for the PDS. A lower percent completeness is acceptable provided that the minimum required number of measurements to satisfy the statistical design is collected. Any deviation from this requirement **SHALL** be documented in the PDSR.

7.3.3 Data Quality Assessment

Data Quality Assessment (DQA) is the scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support the intended use. There are five steps in the DQA Process:

- Review the Data Quality Objectives (DQOs) and Survey Design
- Conduct a Preliminary Data Review
- Select the Statistical Test
- Verify the Assumptions of the Statistical Test
- Draw Conclusions from the Data

These five steps are presented in a linear sequence, but the DQA process is applied in an iterative fashion. The strength of the DQA process is that it is designed to promote an understanding of how well the data will meet their intended use by progressing in a logical and efficient manner.

7.3.3.1 Review DQOs and Survey Design

The DQA process begins by reviewing the key outputs from the DQOs which are embodied in the survey design per the PDSP requirements and the radiological survey package requirements in RSP 16.01. These documents provide the context for understanding the purpose of the data collection effort. It also establishes qualitative and quantitative criteria for assessing the quality of the data set for the intended use. The survey design provides important information about how to interpret the data. The survey design **SHALL** be reviewed before proceeding.

7.3.3.2 Conduct a Preliminary Data Review

In this step the DQA process, a preliminary evaluation of the data set is conducted by calculating some basic statistical quantities and looking at the data through graphical representations. By reviewing the data both numerically and graphically, the "structure" of the data can be learned. This structure will identify appropriate approaches and limitations for data use.

The data may be examined statistically through calculating the mean, standard deviation, median, relative standing, central tendency, dispersion, shape, and association. The data may be examined graphically through the use of histograms, scatter plots, confidence intervals, ranked data plots, quantile plots, stem-and-leaf diagrams, spatial or temporal plots.

For the PDS, the data should be assessed both statistically and graphically. However, there are no minimum requirements for assessing radiological survey/sample data statistically and graphically. Thus, the radiological survey/sample data needs to be assessed so that the structure of the data is apparent.

7.3.3.3 Select the Statistical Test

The statistical test performed to demonstrate compliance with the prescribed limits **SHALL** be selected based on MARSSIM guidance (see Section 10.0, References). Typically, for radiological contaminants, the MARSSIM One-Sample Statistical Test (Sign Test) is preferred. Note that the total average background (LAB and material background, as applicable) **SHALL** be subtracted from each gross measurement prior to the performance of this test.

7.3.3.4 Verify the Assumptions of the Test

The assumptions applied in selecting the statistical test **SHALL** be verified, and the data **SHALL** be reviewed to ensure that modifications to the statistical analysis are not warranted. This step involves the following three activities:

1) Determine how the assumptions of the test will be verified (standard deviations, posting plots, histograms, power charts, etc.)
2) Perform tests of the assumptions
3) Determine corrective actions (if applicable)

For radiological contaminants, the verification of the assumptions of the test can be evaluated per the power of the test. Thus, the actual survey/sample standard deviation is utilized to re-calculate the number of samples required (refer to worksheets in Appendix A) in order to verify that an adequate number of measurements/samples was collected.

7.3.3.5 Draw Conclusions from the Data

The three activities involved with this step are:

1) Perform the statistical tests
2) Evaluate the tests/analyses and corresponding conclusions

3) Evaluate if the survey design is appropriate for further use

Note that when the data clearly show that a survey unit meets or exceeds the release criteria ($DCGL_W$), the result is obvious without performing the formal statistical analysis. Guidance on performing the applicable statistical test is provided in Sections 8.2 and 8.3 of MARSSIM.

8.0 SURVEY REPORTING

Upon completion of a PDS for a Type 2 or 3 facility, a PDSR **SHALL** be prepared. For large clusters (e.g., Building 771), several sub-reports may be developed in lieu of a single large final report in order to simplify and expedite the review process. Each sub-report **SHALL** contain the minimum information described in this plan. In addition, separate reports for radiological and non-radiological data may be submitted, given that the minimum information described in this plan is included in each report. For Type 1 facilities, the PDS results **SHALL** be documented in the RLCR. Note that the requirements of the PDSP **SHALL** be followed when performing RLC/PDS on a Type 1 facility.

The PDSR **SHALL** provide an analysis of PDS results and summarize the conclusion of the PDS. All measurement results used for comparison against the DQO decision rules **SHALL** be presented in the PDSR. Compliance with data review requirements **SHALL** also be documented. The report **SHALL** provide information in adequate detail to allow DOE to make a determination if the facility can be released. DOE will use the report to confirm its status, and will transmit the report and a notification letter to the Lead Regulatory Agency for concurrence. An outline of the PDSR is presented in Appendix C.

8.1 Radiological Summaries

For each Class 1, Class 2, and Class 3 survey unit, the number of measurements and the associated survey results **SHALL** be presented in tabular form. Graphical representation may also be included with the tabular data (if necessary and applicable). For each type of measurement (TSC and RSC), data **SHALL** be reported in units of dpm/100cm^2. Surface media sample data (if applicable) **SHALL** be reported in units of pCi/gram and dpm/100 cm^2.

8.2 Chemical Summaries

The number of measurements and the applicable statistical distribution **SHALL** be presented in tabular form, with additional graphical representation if applicable. The chemical data should be reported in the following manner:

- TCLP measurements will be reported in mg/L.
- Total measurements will be reported in mg/L (liquids) or mg/Kg (solids).
- PCB measurements will be reported in parts per million (ppm) or parts per billion (ppb).
- Be measurements will be reported in micrograms.
- Asbestos measurements will be reported as an asbestos percentage.

9.0 QA/QC PROGRAM

Quality assurance (QA) and quality control (QC) procedures **SHALL** be implemented during the PDS to collect information necessary to evaluate the survey results. Specifically, quality is an integrated system of management activities involving planning, QC, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. QC is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer.

Based on the significance of Pre-Demolition Surveys (i.e., where data are final and are relied upon to ensure safety to the public and environment), there is an additional element of QA/QC, beyond those listed in Section 7 of the DDCP, that is required and presented below:

SURVEY QC REQUIREMENTS

To establish the overall precision, or reproducibility of surveys, replicate, or duplicate, measurements **SHALL** be acquired at a minimum percentage of the "real" (i.e., non-QC) number of surveys. The minimum number of required QC surveys are as follow:

- ≥5% of direct measurement surveys **SHALL** be repeated, and a quantitative assessment **SHALL** be performed where acceptance of the comparison is constituted by either (1) both results <DCGL or (2) <20% difference between the 2 measurements. The duplicate surveys **SHALL** be either random or, if biased, biased toward areas with higher contamination potentials (e.g., floors with embedded drains, ledges, etc.).

Replicate surveys should be performed with a different instrument and by a different surveyor than the one who performed the initial survey, provided that different instruments are available. This method provides a robust estimate of instrument and surveyor precision. The replicate survey results should be clearly marked to show that they are QC surveys and should reference the initial survey for comparison.

10.0 REFERENCES

DOE, CDPHE, EPA, 1996, *Final Rocky Flats Cleanup Agreement*, Rocky Flats Environmental Technology Site, Golden, CO.

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Kaiser-Hill, 1999. *RFETS Decontamination and Decommissioning Characterization Protocol,* MAN-077-DDCP

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MARSSIM - *Multi-Agency Radiation Survey And Site Investigation Manual*, 12/97 (NUREG-1575, EPA 402-R-97-016)

RFETS Beryllium Characterization Procedure, PRO-536-BCPR

RFETS Bulk Solids and Liquids Characterization Procedure, PRO-488-BLCR

RFETS Environmental Waste Compliance Guidance No. 25, *Management of Polychlorinated Biphenyls (PCBs) in Paint and Other Bulk Product Waste During Facility Disposition,* 1999

RFETS Metals and PCB Characterization Procedure, PRO-487-MPCR

RFETS Polychlorinated Biphenyls Management Plan, PRO-673-EWQA-1.5

RFETS Radiological Survey/Sampling Package Design, Preparation, Control, Implementation and Closure, PRO-475-RSP-16.01

RFETS Radiological Samples of Building Media, PRO-477-RSP-16.03
RFETS Radiological Background Determination, PRO-480-RSP-16.06

RFETS Radiological Survey/Sample Data Analysis, PRO-478-RSP-16.04

RFETS Radiological Surveys of Surfaces and Structures, PRO-476-RSP-16.02

RFETS Radiological Survey/Sample Quality Control, PRO-479-RSP-16.05

11.0 GLOSSARY

$DCGL_W$ - Derived Concentration Guideline Level - Contamination limit based on the assumption that the concentration of residual activity is evenly distributed over a large area.

$DCGL_{EMC}$ - Derived Concentration Guideline Level - Contamination limit based on the assumption that the concentration of residual activity is distributed as small-elevated areas within a larger area.

Impacted Class 1 Areas - Areas that have, or had prior to remediation, a potential for radioactive contamination, or known contamination above the $DCGL_W$.

Impacted Class 2 Areas - Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$.

Impacted Class 3 Areas - Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$.

Biased Scan Surveys - Scan surveys that are performed at locations with the highest potential for contamination (e.g., horizontal surfaces, high traffic areas, floor corners, drains) based on professional judgment.

Local Area Background - Background survey instrument readings taken at specific locations within a survey unit in order to determine actual contamination values in a more precise manner.

Non-Impacted Areas - All areas not classified as Impacted Class 1, Impacted Class 2 or Impacted Class 3. These areas are areas where there is no reasonable potential for residual contamination, based on knowledge of building history and/or previous survey information. Sufficient information is present to be assured that no residual contamination is present above the applicable contamination limits.

Measurement Location - A survey location where the typical set of total surface contamination and removable contamination measurements are obtained

Minimum Detectable Activity - The minimum amount of activity that can be statistically detected above background with a 95% probability and with a maximum of 5% probability of falsely interpreting sample activity as activity due to background

Survey Area - The most general category, comprised of surfaces to be further defined as one or more survey units, the bounds of which are defined by existing physical features such as walls, columns, beams etc.

Survey Unit - A contiguous area with similar characteristics and contamination potential. Survey units are established to facilitate the process and aid in the statistical evaluation of the survey data

Survey Design - The process of determining the type, location, number and density of radiological measurements to be taken for final survey

Survey Package - A collection of information in a standardized format for controlling and documenting field measurements taken for final survey. A survey package is prepared for each survey unit. The survey package typically includes the survey instructions, survey data sheets and grid maps.

Survey Point - A smaller subdivision within an area designated as a survey location where measurements are obtained. This area generally refers to the area covered by a detector probe or 100 cm^2 when a smear is obtained.

Survey Instructions - Written instructions which specify the type and number of measurements to be taken in a survey unit. Each survey package shall include survey instructions.

TCLP – Toxicity Characteristic Leaching Procedure; determines the mobility of organic and inorganic analytes present in liquid, solid, and multiphasic wastes.

Appendix A

MINIMUM SURVEY/SAMPLE FREQUENCY REQUIREMENTS FOR STRUCTURES

APPENDIX A
MINIMUM SURVEY/SAMPLE FREQUENCY REQUIREMENTS FOR STRUCTURES

Table A.1
Required Survey/Scan Frequencies

Classification	Surface Scan Coverage	Minimum Number of Measurements (1)(2)	
Class 1	100% of Accessible Surfaces	Total Surface Activity	15
		Removable	15
		Samples	15
Class 2	10 to 100% Floors/Lower Walls 10 to 50% Upper Walls/Ceiling (Random and Biased)[4]	Total Surface Activity	15
		Removable	15
		Samples	15
Class 3[6]	Biased[5] (1-10% of the Total Surface Area)	Total Surface Activity	15
		Removable	15
		Samples	N/A[3]

(1) The minimum number of measurements are based on the *default coefficient of variation* (CV) *values recommended by* MARSSIM. Actual characterization data may be utilized to calculate the required number of measurements by following the calculation guidance provided on the worksheets by utilizing the ACTUAL expected survey/sample standard deviation.
(2) Surface media samples (i.e. paint samples) are not required in areas where surface media has been removed (e.g. scabbled or hydrolazed areas).
(3) Surface media samples are typically not required for Class 3 survey units.
(4) Ceiling is analogous to the roof for exterior survey units.
(5) Scans should be biased towards high traffic areas of each facility such as building entrances, exits, and hallways; HVAC intakes and exhaust ducts; storage areas; areas of frequent personnel contact such as doors, door frames, horizontal surfaces, etc.
(6) For Class 3 Survey Areas, additional BIASED measurements SHOULD be collected as deemed necessary, based on contamination potential.

Table A.2
Survey Unit Surface Area Limits

Classification	Survey Unit Surface Area Limit (1)
Class 1	Up to 100 m^2 floor area
Class 2	100 to 1000 m^2 floor area
Class 3	Up to 1000 m^2 floor area

(1) These size restrictions are guidelines. Larger floor surface areas may be utilized if additional measurements are collected (Increase number of samples by the following:

N = Calculated required number of measurements * [(Actual Surface Area)/(Table A.2 Size Limit)]

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APPENDIX B

CALCULATION WORK SHEETS

Total Surface Activity Measurement Calculation Worksheet
(Default Values to be Utilized when Minimal to No Characterization Data is Available)

Step 1: Determine the relative shift (Δ/δ) in accordance with MARSSIM, Section 5.5.2.3, as follows:

$\Delta/\delta = (DCGL_{TSA} - LBGR_{TSA}) / SD_{TSA}$

$\Delta/\delta_{transuranics} = 2.0 = (100\ dpm/100cm^2 - 40\ dpm/100cm^2)/30\ dpm/100cm^2$

Where:

Δ/δ is the relative shift or the resolution of measurements in units of measurement uncertainty (MARSSIM recommends a value between 1 and 3)

$DCGL_{TSA}$ is the total surface activity derived concentration guideline value (DOE Order 5400.5 total surface activity limit equals 100 dpm/100cm^2 for transuranics, per the B779 Cluster Radiological Closeout Survey Plan)

$LBGR_{TSA}$ is the lower bound of the gray region – the lower bound of the range of values of the parameter of interest in a survey unit where the consequences of making a decision error is relatively minor. The $LBGR_{TSA}$ was adjusted to obtain a relative shift between 1 and 3 (i.e., 40 dpm/100cm^2 for transuranics).

SD_{TSA} is the estimated standard deviation of the total surface activity measurements (MARSSIM recommends assuming a 30% coefficient of variation if scoping or characterization data is not available)

Step 2: Determine the Sign P value by looking up the relative shift (Δ/δ) in Table 5.4 of MARSSIM (the Sign P value is the estimated probability that a random measurement from the survey unit will be less than the DCGL when the survey unit median is actually at the LBGR). The Sign P value from Table 5.4, equals 0.977250 for a relative shift of 2.0.

Step 3: Determine the number of total surface activity measurements for the applicable survey unit using the following MARSSIM, Section 5.5.2.3 formula that is based on Plutonium contaminants not being present in the background:

$N = (1.645 + 1.645)^2 / 4(\text{Sign P} - 0.5)^2$

$N = (1.645 + 1.645)^2 / 4(0.977250-0.5)^2 = 11.88$

Where:

1.645 is the alpha and beta decision error value (95% confidence) per the PDSP

Sign P equals 0.977250

Step 4: Increase N by 20% to allow for missing or invalid data points per MARSSIM, Section 5.5.2.3.

$N = 11.88 \cdot 1.2 = 14.25$

Conclusion: A minimum of 15 Total Surface Activity measurements will required for each survey unit(s).

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Removable Surface Activity Measurement Calculation Worksheet
(Default Values to be Utilized when Minimal to No Characterization Data is Available)

Step 1: Determine the relative shift ($\Delta\delta$) in accordance with MARSSIM, Section 5.5.2.3, as follows:

$\Delta/\delta = (DCGL_{removable} - LBGR_{removable}) / SD_{removable}$

$\Delta/\delta = 2 = (20 \text{ dpm}/100\text{cm}^2 - 8 \text{ dpm}/100\text{cm}^2)/6 \text{ dpm}/100\text{cm}^2$

Where:

Δ/δ is the relative shift or the resolution of measurements in units of measurement uncertainty (MARSSIM recommends a value between 1and 3)

$DCGL_{removable}$ is the removable surface activity derived concentration guideline value (DOE Order 5400.5 removable surface contamination limit equals 20 dpm/100cm^2 for transuranics)

$LBGR_{removable}$ is the lower bound of the gray region - the lower bound of the range of values of the parameter of interest in a survey unit where the consequences of making a decision error is relatively minor. In order to obtain a relative shift between 1 and 3, the chosen LBGR is 8 dpm/100cm^2 for transuranics.

$SD_{removable}$ is the estimated standard deviation of the removable surface activity measurements (MARSSIM recommends assuming a 30% coefficient of variation if scoping or characterization data is not available) Since the B729 scoping or characterization data did not contain actual values less than the MDC of the counting instrument, a value of 6 dpm/100cm^2 will was used.

Step 2: Determine the Sign P value by looking up the relative shift ($\Delta\delta$) in Table 5.4 of MARSSIM (the Sign P value is the estimated probability that a random measurement from the survey unit will be less than the DCGL when the survey unit median is actually at the LBGR). The Sign P value from Table 5.4, rounded conservatively, equals 0.977250 for a relative shift of 2.

Step 3: Determine the number of removable surface activity measurements for the applicable survey unit using the following MARSSIM, Section 5.5.2.3 formula that is based on Plutonium contaminants not being present in the background:

$N = (1.645 + 1.645)^2 / 4(\text{Sign P} - 0.5)^2$

$N = (1.645 + 1.645)^2 / 4(0.977250 - 0.5)^2 = 11.88$

Where:

1.646 is the alpha and beta decision error value (95% confidence) per the PDSP

Sign P equals 0.977250

Step 4: Increase N by 20% to allow for missing or invalid data points per MARSSIM, Section 5.5.2.3.

$N = 11.88 \cdot 1.2 = 14.25$

- Conclusion: A minimum of 15 removable surface activity measurements will be required in each survey unit(s).

Media Surface Activity Measurement Calculation Worksheet
(Default Values to be Utilized when Minimal to No Characterization Data is Available)

Step 1: Determine the relative shift ($\Delta\delta$) in accordance with MARSSIM, Section 5.5.2.3, as follows:

Note: Since a reference area background subtract will not be used for uranium measurements and since the equation in Section 5.5.2.3 results in a larger number of samples than the equation in Section 5.5.2.1 for a relative shift of 2.0, it is acceptable to use the equation in Section 5.5.2.3 for uranium.

$\Delta/\delta = (DCGL_{media} - LBGR_{media}) / SD_{media}$

$\Delta/\delta_{transuranics} = 2.0 = (100\ dpm/100cm^2 - 40\ dpm/100cm^2)/30\ dpm/100cm^2$
$\Delta/\delta_{uranium} = 2.0 = (5000\ dpm/100cm^2 - 2000\ dpm/100cm^2)/1500\ dpm/100cm^2$

Where:

Δ/δ – is the relative shift or the resolution of measurements in units of measurement uncertainty (MARSSIM recommends a value between 1and 3)

$DCGL_{media}$ is the total surface activity derived concentration guideline value (DOE Order 5400.5 total surface contamination limit equals 100 dpm/100cm^2 for transuranics and 5000 dpm/100cm^2 for uranium, per the B779 Cluster Radiological Closeout Survey Plan)

$LBGR_{media}$ is the lower bound of the gray region – the lower bound of the range of values of the parameter of interest in a survey unit where the consequences of making a decision error is relatively minor. The $LBGR_{media}$ was adjusted to obtain a relative shift between 1 and 3 (i.e., 40 dpm/100cm^2 for transuranics and 2000 dpm/100cm^2 for uranium).

SD_{media} is the estimated standard deviation of the media surface activity measurements (MARSSIM recommends assuming a 30% coefficient of variation if scoping or characterization data is not available) (i.e. 30 dpm/100cm^2 for transuranics and 1500 dpm/100cm^2 for uranium).

Step 2: Determine the Sign P value by looking up the relative shift ($\Delta\delta$) in Table 5.4 of MARSSIM (the Sign P value is the estimated probability that a random measurement from the survey unit will be less than the DCGL when the survey unit median is actually at the LBGR). The Sign P value from Table 5.4, equals 0.977250 for a relative shift of 2.0.

Step 3: Determine the number of media surface activity measurements for the applicable survey unit using the following MARSSIM, Section 5.5.2.3 formula that is based on Plutonium contaminants not being present in the background:

$N = (1.645 + 1.645)^2 / 4(\text{Sign P} - 0.5)^2$

$N = (1.645 + 1.645)^2 / 4(0.977250\text{-}0.5)^2 = 11.88$

Where:

1.647 is the alpha and beta decision error value (95% confidence) per PDSP

Sign P equals 0.977250

Step 4: Increase N by 20% to allow for missing or invalid data points per MARSSIM, Section 5.5.2.3.

N = 11.88 * 1.2 = 14.25

Conclusion: A minimum of 15 media surface activity measurements will be required in each survey unit.

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APPENDIX C

PRE-DEMOLITION SURVEY REPORT

PRE-DEMOLITION SURVEY REPORT

LIST OF ACRONYMS

EXECUTIVE SUMMARY

INTRODUCTION
Report Purpose
Characterization Scope
Data Quality Objectives

RADIOLOGICAL CHARACTERIZATION AND HAZARDS

CHEMICAL CHARACTERIZATION AND HAZARDS
Asbestos
Beryllium
RCRA/CERCLA Constituents
PCBs

PHYSICAL HAZARDS

DATA QUALITY ASSESSMENT

CONCLUSION

REFERENCES

ATTACHMENTS